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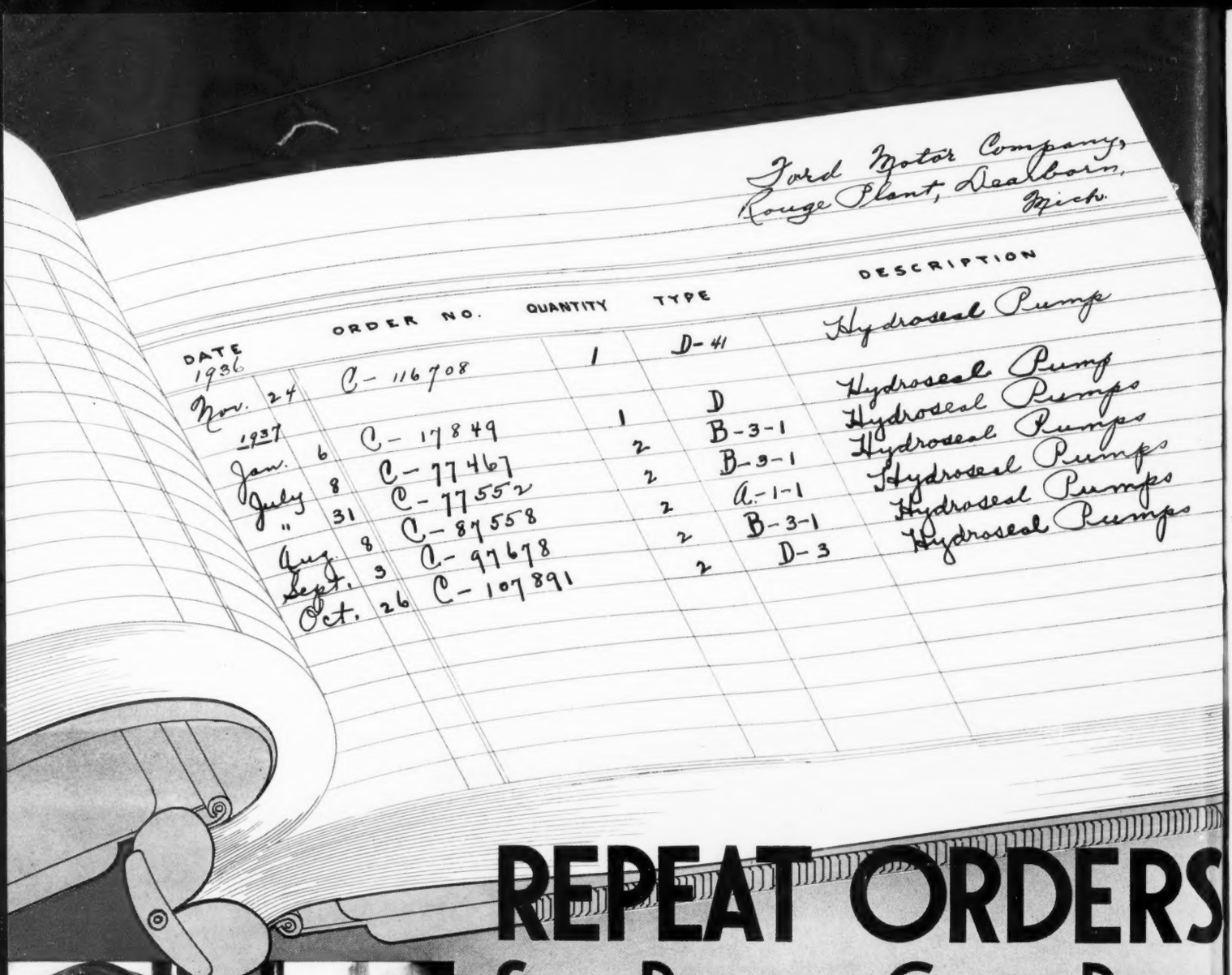

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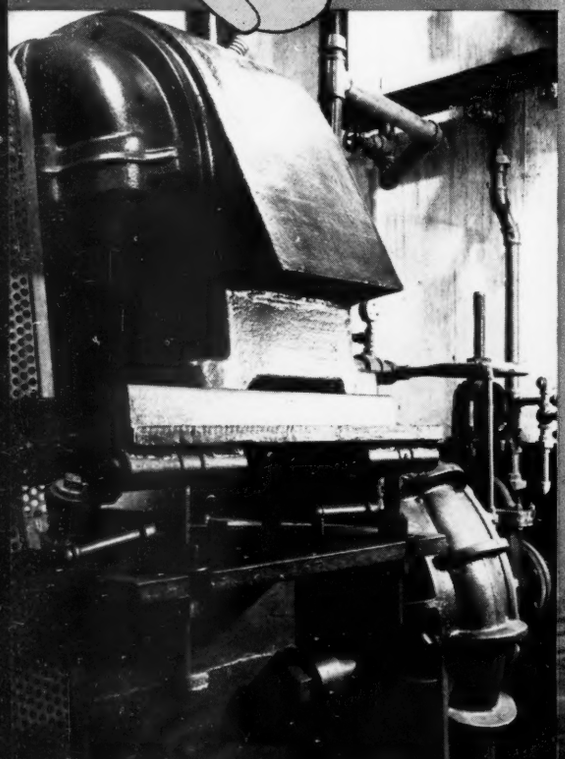

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Meet the Coal Man

MINING IS MINING, whether the product won be coal, or metals, or some non-metallic or petroleum. Graduate engineers for the most part have been taught the fundamentals of their profession without respect to any particular one of the extractive industries. So it is not surprising that, once launched on their life work, the young men are found distributed among the several branches of mining named; nor is it unnatural that, as the years slip by, they should tend to specialize in the branch where they received their start. But truly it is astonishing when they turn their backs, as they so often appear to do, upon the progress and achievement scored in the branches of mining other than their own. At times it seems almost as if some of the groups saw in the others an unpardonable inferiority. Certainly, no great interest in each other has been displayed by the coal and metal mining industries in the United States. Yet each can learn much from the other.

Engineering developments in the coal industry have moved apace, the practices adopted at times anticipating or surpassing those of the metal mining field, the reverse being true at others. To neither industry belong all the honors.

The urge to electrify seized the coal man long ago. The first electric coal cutter appeared in 1888, a year after the debut of the electric locomotive and the first mine surface lighting system. And in 1911 the use of electricity began to outstrip that of air for operating purposes. Mechanical loading of coal started with the introduction of the Stanley header in 1890; and in 1903, after ten years of effort, the first mobile loader was put upon the market. Conveyors underground in coal mines were first tried in 1902, in the United States at least, and scrapers in 1917. As for coal transport underground by other means, one operator is now using mine cars having a capacity, level full, of 334 cu.ft.

Surface excavators used in coal have seen a great development. The industry's first steam shovel, introduced in '77, has its modern counterpart in the huge electric units of today with dipper capacities running up to 34 cu.yd. In the field of ventilation, one notes that the modern propeller-type fan got its start in coal mining. And the electric cap lamp, still so new in many metal mines, if used at all, has been known to coal miners since 1911.

These facts, culled from history, not for purposes of comparison but rather to show that metal mining has had no monopoly of progress, suggest that current developments in the coal industry may also merit consideration by the metal miner. Attention is directed to the description, elsewhere in this issue, of a sink-and-float separation process that utilizes various heavy liquids. Results of tests made on large tonnages of coal over a two-year period indicate the possibilities of applying it commercially in this field. And further application of it is suggested by the outcome of work done with it on various minerals also. The data derived are welcome at a time when interest has steadily been growing in the metal mining field in ore beneficiation employing heavy suspensions as media for separating valuable minerals from their gangue. The new development should draw attention.

The Irrepressible Promoter

CONTEMPLATION of geologic time and the processes at work beneath the surface of this old Earth since it began is tremendously inspiring to many an untutored man, who nevertheless, because of his ignorance, is unable to voice the thoughts that arise within him without making some bad break. Unfortunate this is, though usually harmless. It is only when our sentimental ignoramus sets out to turn his sentiment into cash at the expense of others who know as little as he, or less, that he becomes a candidate for correction by the agencies of the law. Endless quotations might be made from

the overflowing stream of prospectuses or sales letters that arrive despite the menace of the S.E.C. In the end one becomes bored instead of amused and feels that the "sucker" will have to look out for himself. Thus the reaction to the circular of a "practical prospector" who expatiates on the wonders of the Cherry Creek district, near Jerome, Ariz. Though "turned down 1,000 times," this district possesses "speculative possibilities," shown by a "geophysical survey" made by the writer, that amount to no less than 78 billion tons of ore, which he assumes may average $5 per ton. "Therefore," he concludes, "there is enough hidden ore in this district that can be mined and milled for 75 cents per ton to pay large dividends for years to come." Highly speculative indeed are these possibilities!

Wanted: Consumers of Metals

A SUMMARY of first-quarter statistics for the major non-ferrous metals reemphasizes the dependent character of the mining industry as a producer of raw materials. Unless metal-consuming industries are active, mining cannot flourish. Even a cursory glance at the record shows that those who direct the destinies of copper, lead, and zinc mining have to cope with well-nigh impossible conditions, particularly when industrial activity is waning. Although metal production may be curtailed, consumption usually falls in still greater volume, stocks increase, and prices drop. Time is required to restore equilibrium.

The problem is a little less acute with rising industrial activity. Stocks of metals are available, usually at low prices. But the time and rate at which mining shall be resumed still remains to puzzle producers, and the situation has its dangers. Witness what happened a year and a half ago. The spirited buying of raw materials that characterized the last quarter of 1936 and the first quarter of 1937 did not grow out of thin air. There were good reasons for the rush for commodities. The scramble was world-wide. Demand in many instances exceeded production; and producers, particularly of such commodities as copper, could not increase output fast enough to prevent a runaway market. Fear gripped first the consumer and later the producer—"fear of war abroad, fear of inflation, fear of nation-wide strikes"—and despite the President's debatable assertion that these fears were not realized, they had dire effects. Fear doesn't wait on reason or logic; it generates immediate action.

So the inevitable time lag in producing raw materials manifests itself equally in periods of rising and falling industrial activity, and is intensified rather than softened by political influences. Corrective economic forces that were quietly at work more than a year ago to end a runaway market and bring about an orderly relation between production and consumption were upset by the President's sharp warning on prices and the adoption of a policy of deflation. That policy has now been reversed, introducing a new political complication in an already difficult economic condition. And the cycle will be repeated if the Administration insists on trying to control it.

The need for metal consumption at a steady and uniform rate is clearly shown in the following statistics, comparing conditions in the first quarters of 1937 and 1938. Production, deliveries, and stocks are given in short tons; prices in cents per pound.

	January–March	
	1937	1938
COPPER		
U. S. production, refined	223,006	190,977
U. S. deliveries	250,252	85,704
Stock at end	121,448	342,785
Average price	13.872	9.916
LEAD		
U. S. production refined	124,905	110,501
U. S. deliveries	159,518	96,110
Stock at end	137,204	143,511
Average price	6.476	4.667
ZINC		
U. S. production, all grades	131,043	133,232
U. S. deliveries	157,815	79,999
Stock at end	18,183	118,009
Average price	6.564	4.743

Stocks of duty-free refined copper in the hands of producers nearly trebled in a year, and deliveries fell to a fraction of their 1937 tonnage. The position of lead is more favorable, due mainly to producers' policy of not selling to consumers for future delivery beyond three months. In zinc the condition was aggravated a year ago by active demand coupled with a power shortage in the Northwest which seriously reduced production. Now stocks have increased to a point where further curtailment of production seems necessary.

The month of April saw virtually no improvement in the buying of non-ferrous metals. What is needed to ward off further drastic curtailment in production is a rapid expansion in the actual consumption of the three metals. If that expansion is to occur, utilities must buy line materials and equipment in quantity, construction and manufacturing will have to revive, and automobiles must again roll from the assembly lines at a normal rate. In short, there must be a return of confidence, which is made difficult by uncertain political conditions. The key to recovery lies in resumption of industrial production, not in Federal spending and lending, nor in political panaceas.

THE GOVERNMENT PIER at Larena on Siquijor. Here Mine Factors loads most of its ore. Shipments are made to Japan and the United States

The Philippines

A New Source of Manganese

Industry is still young—Much of the ore known will require beneficiation—Exports not likely to exceed 100,000 *tons in* 1938

Ralph Keeler
Manila, P. I.

EXISTENCE of manganese ores in parts of the Philippine Islands has been known for 30 years, but not until quite recently has there been much activity in their exploration. During the past two years exploration has verified earlier reports and has made it possible that the Philippines may be able to export sizable quantities of manganese ore of good quality. So far, however, the industry is still in its infancy. Exports for the years 1936 and 1937 as listed by the Bureau of Customs in Manila are given in Table I, on page 32.

Prospects for 1938 are not particularly bright, although production will shown a marked increase. Total exports will hardly be over 100,000 tons, as far as can be predicted from present plans of operating companies.

Philippine manganese occurs mostly in small lenses, scattered from one end of the Islands to the other. Grade of ore is often high, running from 45 to 50 per cent, but in almost every instance the ore is so mixed with gangue that much sorting, either by hand or mechanical, is necessary. Many trial shipments during the past two years have been unsatisfactory to buyers because of high moisture and a manganese content lower than predicted.

The main drawback has been the lack of experienced operators. There are 33 companies, with paid-in capital amounting to 2,461,163 pesos, which are classified as manganese companies. Of these, only two are actually engaged in mining; a few of the others are gathering float ore from time to time, and most of the rest have spent their money in ill-advised attempts at development or mining. Few men in the Islands have experience in operating manganese properties; in fact, only three companies have officials who have more than the vaguest idea as to the solution of the problems met.

From the experience of the companies which have made trial shipments, it seems obvious that some sort of beneficiation process will be necessary before shipments of uniform-grade, clean, and dry manganese ore can be made with any regularity. The system of gathering float and of mining more or less haphazardly from open-cut workings, has not been satisfactory to buyers. Various contracts have been cancelled because the companies were unable to make deliveries.

Manganese has been found in Ilocos Norte; Masbate; Pangasinan; Nueva Ecija; Abra; Tawitawi Islands, in Sulu; Capiz; Catanduanes Island, in Albay; Tarlac; Nueva Vizcaya; the Mountain Province; Camarines Sur; Busuanga Island, near Palayan; and Siquijor Island, at the southern tip of Cebu. Active mining today is concentrated in three areas: Ilocos Norte, Busuanga Island, and Siquijor Island. Most of the ore mined is being shipped to Japan, and contracts which will be filled this year are chiefly with Japanese users. The United States is the second largest buyer.

Ore reserves, estimated by the various companies owning manganese claims as of Jan. 1, 1938, amount to 560,000 tons valued at 7,704,000 pesos. These figures have not been checked, however, and it is doubtful if that much has really been proved.

Ilocos Operations[1]—The oldest manganese producer in the Islands is the Ilocos Manganese Mining Company, formed in 1934. The property comprises 48 claims, 28 of which are at Punta Negra, about 3 km. north of Burgos, and the remaining 20 claims at Siec, about 5 km. south of Burgos.

[1] "Mineral Resources of the Philippines for 1926 to 1933," Manila, Bureau of Printing, 1936.

In 1906 F. D. Burdette found manganese occurring in layers at Punta Negra, and nodules and grains at Siec. The property is in low rolling country, maximum elevation being about 1,000 ft. He opened trenches in the deposit at Punta Negra, but no production was recorded. In 1916 the two deposits were worked, and 3,000 tons, valued at 30,000 pesos, were shipped to Japan. In 1918, 650 tons, valued at 9,000 pesos, were mined but not sold. In 1934 an American "old-timer," J. J. Rafferty, formed the Ilocos Norte Manganese Association to make a new attempt in the same place. This later became the Ilocos Manganese Company. From 1934 to 1937 extensive development work was done by Mr. Rafferty. In 1935 a trial shipment of 500 tons of ore was made to Japan which averaged 42.4 per cent Mn, 7.6 per cent SiO_2, and 0.036 per cent P.

The predominating rock of the region is an agglomerate which is almost completely surrounded by sedimentaries. Pyrolusite and psilomelane occur in veinlets in the agglomerate and in layers over the sedimentaries. Erosion and subsequent concentration resulted in residual deposits which are found in many localities in the district. The gangue is mainly sand and clay.

At Punta Negra the manganese bed is exposed along its strike for about two kilometers. It dips 12 deg. south and is 2 ft. thick. At some places over 300 ft. of bed is exposed along the dip. The annual report of the company for 1937 showed positive ore reserves of 15,000 tons ready for mining, with several years' supply of probable and possible ore likely.

At Siec the residual deposit covers an area of approximately thirteen full-sized claims. The deposit, which consists of nodules and grains mixed in the soil and varies in thickness from 2 in. to 10 ft., has been exposed by open trenches and by old open cuts. Reserves in June, 1934, were estimated at 1,000 tons of positive ore, 87,225 tons of probable ore, and 1,500,000 tons of prospective ore (not checked by actual mining yet).

At Punta Negra six channel samples across the deposit gave an average content of 21.07 per cent metallic manganese. A picked sample from the bed and a grab sample from several piles of manganese ore gave 52.91 per cent and 42.48 per cent, respectively. At Siec three samples taken across the vertical depth of the residual deposit gave an average of 25.29 per cent. A grab sample from several piles of ore gave 39.26 per cent manganese.

The Ilocos Manganese Mining Company is mining the residual deposit at Siec by means of open cut under the *pakiao* system. Under this system the company furnishes tools, such as crowbars, picks, and shovels, to a group of workers who are assigned to a given piece of ground under a *capataz*. A given group usually comes from the same *barrio*, and works as may be most convenient. The workers have no fixed working hours and are not interfered with by the manager. They are paid fixed prices for the ore recovered and delivered alongside the road. About 1,000 tons have been mined this way and piled at the road at an average cost of 4.60 pesos per ton. The method is not economical, small pieces of high-grade being left behind. The ore will probably have to be washed, crushed, and concentrated.

TRENCH at the Panlitan mine of the Union Manganese Association on Busuanga, some 200 miles by water from Manila

Ore recovered from shallow pits is hand-screened with bamboo screens of about ½-in. opening. Undersize, consisting of clay and small manganese pebbles, goes to waste, and the oversize is washed with water in kerosene cans. The washed product runs 40 per cent manganese.

The large pieces should be crushed to remove the inclosed clay and sand. For commercial treatment the following flowsheet has been recommended to the Ilocos company. A revolving scrubber followed by a two-deck trommel. The oversize of the inner deck should go to a crusher, and the crushed product be returned to the scrubber. The intermediate product between the trommel decks should be the finished product. All undersize and wash water should pass over tables to remove the sand and clay tailings. The concentrate and the intermediate product of the trommel should constitute the finished product, and the tailings should go to waste.

During 1937 the company completed a good road to the coast, and is now able to bring to the seaside 750 tons of ore a day, with an increase of 1,000 tons possible if mechanical cleaning be provided.

A contract has been signed between Ilocos Manganese and the Grawfus Mining Company, whereby the latter will finance operations of the former's property. The directors of Grawfus are Manila business men who also represent buyers' agents for manganese. Work has been carried on conservatively, and plans are under way for installing machinery and equipment for beneficiation.

Busuanga Operations — A number of companies are operating near Busuanga, on Palawan, but only one, the Philippine Nippon Mining Company, has shipped any ore (900 tons were sent to Japan by this company in January, 1938). The other firms have had, and are still having, difficulty in obtaining uniformity of grade and in concentration. Excessive moisture is also a big factor here. No information is available in Manila as to the activities of Philippine Nippon, which is capitalized at 225,000 pesos, all paid in. The company is under Japanese control, although it has a dummy Filipino board.

The Union Manganese Association has done much work in this area. Officials report that contracts for the entire output are pending, and that 3,000 tons of different grades of ore have been piled ready for shipment. No shipments have yet been made.

The Union property is near Bintuan, Busuanga, about 200 miles from Manila by boat. Topography is one of gentle relief. The country north and northwest is traversed by an evenly running valley slightly above sea level. The hills are from 400 to 750 ft. high, and are covered with a thin clay-sand soil and *cogon* growth, although occasionally thick tropical forest growth is found. Because of differential resistance to erosion, the point where the limestone replaces the dominant quartzite formation can be seen from a distance, since in such cases the area is more densely forested and rugged in topography than the grass-covered quartzites.

Busuanga Island is in a group comprising the Palawan Cuyo Islands. Geologically they occupy a distinct division of the Philippines. Most of the southern periphery of these islands, including Coron Island, consists of limestone formation, whereas the central and northernmost part of Busuanga is composed of highly metamorphosed, twisted, crushed, and contorted quartzites, yellow to pink in color, and highly jointed. No volcanic rock has been observed on the property. Beds of jasper and hornstone are noted, but the field relations of this jasper are obscure, and it is not known to what extent the forma-

tion influences the structure of the area, nor is the relation of the quartzite to the jasper known. Field observations, however, tend to show that manganese ore concentrations are wholly confined to fine-grained and compact jaspers.

Manganese occurs as leads along the fissures of jasperoid rock and through country rock devoid of any fissuring. The laminaes of jasper are found most conspicuously where manganese outcroppings are exposed. The development of manganese ore in jasper and quartzites is believed to result from complex geochemical reactions. Part of the manganese ore resulted from the degradation of old land areas. The residual manganese closely follows the configuration of the surface. Ore found on the Union Manganese property[2] in the form of narrow laminaes, leads, and pocket concentrations is mainly pyrolusite. There are no true veins of manganese ore, and the deposits must be considered as isolated pockets, lenticular lenses confined chiefly to the zones of crushing and shearing.

Ore found is of high grade, the stockpiles resulting from hand-picking averaging 45 to 55 per cent Mn.

Inspection of a prospect near Borac, in Busuanga, was made by G. H. Newman in June, 1937, for Marsman & Company. He reported that the main deposit occurs as a lenticular body whose outcrop is 180 ft. long and about 50 ft. high. Its thickness ranges from 2 to 4 ft. around the edges to over 5 ft. in the central section, and may easily exceed this, as there is pronounced thickening in the lower sections of the outcrop. The main lens strikes northwest-southeast and dips at 60 to 70 deg. NE. The hillside slopes at about 20 to 25 deg. in the same direction. Short crosscuts can be used to open up the lower portions.

The ore is hard, massive psilomelane, and the wall rocks are thin-bedded cherts. The ore will probably average over 50 per cent metallic manganese. There are no beds or horses of chert in the ore. Evidence favors an hydrothermal origin for this ore, which in turn favors the possibility of the ore continuing to some depth. There are prospects of finding other small bodies of similar ore on the claims.

No ore has been produced, but it is believed that about 12,000 long tons of ore containing 50 per cent Mn are available from float outcrops and ore in place to a depth of 50 ft. on the main lens. For each additional 50 ft. the deposit continues downward there is a possible 6,000 long tons, and it is probable that the orebody will continue to a depth of at least 200 ft.

Little labor is available in the district. Most of it would have to be brought in, particularly skilled labor. Ample water is available within a few hundred feet of the deposits. Little timber will be required at a mine of this type, and most of it could be acquired locally. Some special sawed lumber might have to be brought in. Transportation of this ore to a suitable deep-water harbor would require about 5 km. of truck road or narrow-gage railroad constructed over a practically level route.

Siquijor Operations—Regular shipments of manganese ore have been made to Japan and the United States from a property in the northeastern part of Siquijor Island, about 400 miles southeast of Manila. The group consists of nineteen claims operated by Mine Factors, Inc., an independent company organized in Manila early in 1937. Mine Factors made its first shipment in August, 1937, and from then until the end of the year, 9,786 tons were produced. The company has two main contracts, one for shipment to Japan and one for shipment to the States. It is planned to increase shipments to 10,000 tons per month during February, and, on completion of a new conveyor system and a loading dock early in June, to effect a further increase.

The following description of the Siquijor property was condensed from a report of E. W. Bedford, mining engineer, who examined the property for Mine Factors.

Occurrence of manganese ores on Siquijor has long been known, but no effort was made to develop this ore until recent demands for the metal became evident. The ore is predominantly pyrolusite, and runs well over shipping grade. Table II shows a comparative analysis by mine and by buyer of the first few shipments made. Iron and silica content, as may be seen, is low, so that no penalties need be paid. Limitations for this type of ore are a maximum of 6.0 per cent Fe, 12.0 per cent SiO_2, 0.15 per cent P. For each 1 per cent of silica in excess of the maximum there is a deduction of 0.50 pesos per long ton. For each 1 per cent Fe in excess of the maximum there is a deduction of 0.50 pesos per ton.

The area in which the deposit occurs extends northerly on a comparatively broad peninsula forming the northeast quarter of the island. This is divided by a single watershed which rises to elevations about 400 meters above sea level. Present operations of the company are being carried on

CABLEWAY DEPOSIT (above) of Mine Factors on the Island of Siquijor, 400 miles southeast of Manila. The laborers work under the *pakiao* or task system. The lower cut shows the ore-washing equipment and stockpile of Ilocos Manganese Mining Company, near Burgos, Ilocos Norte

[2] Description of Union Manganese property from report of I. Konkoff, engineer for the company.

near the summit of the watershed, on the east-facing slope, at an elevation of about 280 meters. Other near-by ore exposures approximate 300 meters in elevation. The area is somewhat sparsely forested. Typhoons or other influences are more of an interference with operations than are seasonable heavy rains.

Near the main orebody two major fault planes exist, one which has dislocated and caused an upthrust, and a subsequent overslide of the ore measure along the easterly extent of the deposit. The latter fault is vertical and has a strike N. 40 deg. W. The westerly component of this shear leaves the formations, and the ore area, almost in normal repose. Its east component is highly dislocated and reposes at a north dip angle of 75 deg. and is further complicated by a secondary fault which parallels the measure. The escarpment of this shear serves as an excellent wall for the pit operations localized in this area, but it may inconsistently become a source of difficulty due to the likelihood of slides, especially after somewhat deeper horizons of ore are removed from the pit.

Ore occurrence is similar to that of a coal deposit, being the deposition of manganese solutions to, and replacement by them of, calcareous strata in the Canguinsa series of sandstones and clay shales. This has apparently been a mineralization transpiring on some Miocene superficial horizon which has subsequently been buried by ages of younger strata completing the vast sedimentary series. The conclusion is that the original undisturbed measure extended to an area of considerable expanse, verified by the average 12-ft. thickness and the relatively high degree of replacement of the calcareous constituent of the strata by manganese as pyrolusite.

Mass land elevation, subsidence, and re-elevation have largely obliterated the original identity of the strata composing the orebody. It is indicated, however, that an extraordinarily large mass of the orebody still remains common to the dislocated and warped strata remnants between segments of the block-faulting affecting the area examined. All exposures are common to the original bedding of this area; the strata have been segmentally upthrust along a series of shear planes affecting, perhaps, all horizons of the sedimentaries. This mineralization cannot be classed as a vein structure, or even as a blanket vein. It may be more adequately termed a measure corresponding to coal seams, or limonite ore beds. Mining methods are comparable, but overburden removal will constitute a real problem as operations are continued. The upper uneroded segments of the orebody are superficially concentrated, due to long exposure. The upper or surface strata, 5 or 6 ft. thick, may easily be sorted by hand. A system of log washing would unquestionably make a higher ore recovery, and would be readily adaptable to the lower-valued clay and pyrolusite deposit beneath the surface enrichment. Some areas of the latter nature reach a depth of 20 ft. as observed in the shafts.

The deposit between the walls of the measure is not entirely massive throughout. Channeling of solutions around impervious structures has influenced, in some degree, barren or low-valued portions. This has not been extensive, however, and close observation of the several portions of the area permits control of waste elimination.

In mining operations, the *pakiao*, or task, system is employed, and the employees appear to be contented, inasmuch as they complete their allotment within prescribed hours. It is anticipated, however, that, with increasingly difficult conditions, there will be some restlessness among the *pakiao* groups. However, these phases, as they develop, are subject to adjustment after due consideration of the problem by responsible staff officials.

Operations are under a series of *capataces*, who supervise *pakiao* groups whose duties are to mine and select the ore and carry the selected ore product, in baskets weighing an average of 125 lb., to stockpiles beside loading ramps for the trucks. Checkers account for the daily *pakiao* of the groups, and samplers extract a given amount from each basket for a composite sample.

Employees under *pakiao* are not permitted to follow high-grade ore. They mine everything as they advance; therefore no untoward depletion of high-grade ore is experienced.

It is possible that waste material from current operations is not being sufficiently removed against an ultimate necessity of mining lower horizons of the ore measure. Interference of overburden will be an increasingly difficult problem. This applies especially in the Tipolo tree area. Some means of benching will ultimately be required. Officials of the company report that a successful solution of overburden problem has been found by a system of partial stripping.

A point of particular concern is that consideration must be given slides which may interfere with the general easterly portion of the open pit. This situation is not as important in the dry season as during rainy periods.

Trucking is at present carried on with eight trucks which haul an average of 3 long tons per trip. A given truck should average in excess of 50 long tons per 24-hour day. The ore is loaded in baskets which are trucked intact to the Larena stockpiles. Loading crews at the mine, and unloaders at Larena, have been trained to handle the ore expeditiously.

Ore reserves, calculated after deductions for waste elimination, dilution, moisture, and based on dry tons available, are as follows: Net proved tonnage, 70,207; net probable tonnage, 210,292; total evaluable tonnage, 280,499; value at 19.00 pesos per ton, 5,320,000 pesos.

Shipments made this year to date (March 1) amount to 20,000 tons, the quality of which has averaged well over 49 per cent manganese, with impurities below penalty grade.

Mining costs to date have averaged 5.00 pesos per ton at the mine, including loading, and 1.20 pesos Manila office overhead, a total of 6.20 pesos per ton. Operating profit was thus 12.80 pesos per ton, the price paid being 19.00 pesos per ton. Increase of production, now going on, has brought additional expense for the mechanization of the operation, and a consequent increase in costs. It is estimated, however, that a profit of 10.00 pesos per ton can be consistently realized. New equipment to be bought includes excavating machinery for overburden and ore, road-construction machinery, a log-washing plant, pier expansion, and other incidentals, all to cost around 112,500 pesos.

Current prices in Manila for manganese ore averaging 45 per cent Mn, 6 to 7 per cent silica, 8 per cent Fe, 0.2 per cent P, trace or 0.08 per cent S, are: f.o.b., 16.40 to 20.00 pesos per ton of 2,240 lb., with 0.50 pesos additional for each 1 per cent increase Mn in general average; offered by an English buyer, loading at Cebu. Japanese buyers (Mitsui) offer 22 pesos per ton for 49 per cent Mn, usual specifications.

Table I—Exports of Manganese Ore From the Philippines

	1936		1937	
	Long Tons	Value, Pesos	Long Tons	Value, Pesos
United States	254	6,000	4,714.7	81,050
Japan	0.97	20	7,491.3	256,556
Italy	None	...	0.2	10
Totals	254.97	6,020	12,206.2	337,716

Table II—Analysis of Shipments From Siquijor

	Shipment No. 1 %	Shipment No. 2 %	Shipment No. 3 %
(Mine analysis)			
Manganese	45.05	45.42	49.90
Silica	3.37	4.30	4.28
Iron	1.40	3.52	1.30
Phosphorus	0.64	0.14	0.09
Moisture	...	12.50	13.75
(Consumer's analysis)			
Manganese	49.60	48.50	49.20
Silica	4.00	1.20	4.30
Iron	1.90	1.80	3.50
Phosphorus	0.114	0.111	0.140
Moisture	7.0	...	...

Sink-and-Float Separation Commands New Attention

Du Pont laboratories develop process and equipment using heavy liquids

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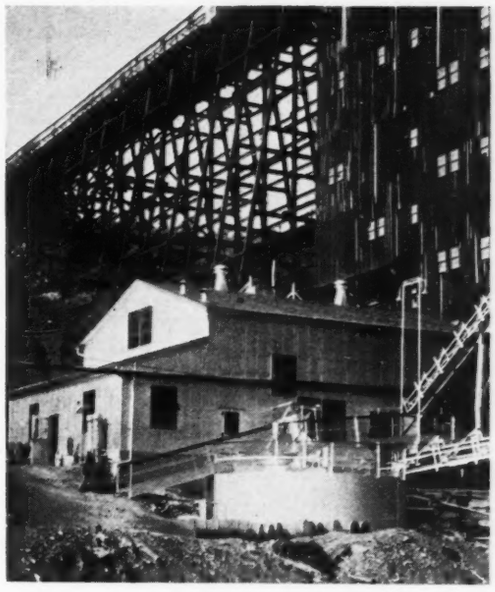


The sink-and-float plant at Shenandoah, Pa.

► AT THE PRESENT TIME *metal-mining companies in several parts of the United States are seriously experimenting in plant and laboratory with apparent density separations to improve the beneficiation of their ores. The separating media employed in these cases consist of heavy suspensions of various sorts. Much is being learned. The body of knowledge thus being amassed is greatly amplified by data on work done over many years using liquids of heavy specific gravity as the means of separating valuable minerals from the accompanying gangue or waste. Practical results achieved with the halogenated hydrocarbons, represented by tetrabromethane, pentachlorethane, and trichloethylene, and mixtures of them to give the desired specific gravities are described in the following article. Although coal is the material principally referred to, the application of the process to a wide range of other minerals appears feasible and likely.*

IN HIS "Handbook of Ore Dressing" that appeared in 1927, A. F. Taggart, of the School of Mines, Columbia University, speaking with respect to the application of sink-and-float testing to coal, said:

"On the basis of sink-and-float tests, the percentage of the total raw coal that will float in a solution, the specific gravity of which is that of the maximum specific gravity of salable coal (permissible density), represents the highest possible percentage recovery of salable coal, and the percentage of total combustible therein contained represents maximum recovery of combustible."

This statement is applicable to minerals provided it is possible to secure a liquid of the proper specific gravity for separating the economically valuable mineral from the accompanying gangue.

Authentic records are available which show that as early as the middle of the Nineteenth Century ferric chloride or sulphuric acid was suggested for such use in the separation of coal and slate. In fact, attempts were made in England, about that time, to run the ferric chloride process in competition with jigs. This enterprise, however, was unsuccessful. From then on, efforts to use various heavy liquids as a means for separating impurities from minerals and slate from coal have been made by numerous individuals and corporations, the advantages of straight gravity separation being well recognized by all familiar with the art of ore dressing or coal beneficiation.

About 1902, T. Coleman du Pont, Pierre S. du Pont, William du Pont, and Francis I. du Pont, recognizing the possibilities of a process in which high-gravity liquids could be used as separating media for minerals, decided to attempt the development of such a process.

A. J. Moxham became associated with them and work was begun on the brown iron ores of Virginia (limonite). About 1904, the first experiments were made at the du Pont company's experimental station. At that time, there were no commercial quantities of suitable heavy liquids, and these gentlemen believed that molten chemicals could be used successfully. Their efforts, therefore, were limited to the development of a process wherein tin bromide or antimony bromide in a molten state would be used as the heavy liquid. The process was developed to such an extent that ore was treated with great success from the standpoint of producing a high-grade concentrate. The difficulty of procuring sufficient materials from which to manufacture the molten chemicals and the high cost of the process brought this particular development to an end. From that time until the beginning of the World War, various members of the group carried on a research program looking toward the development of heavy liquids which would have the proper specific gravities and be sufficiently low in price to permit their use in commercial operations. After the war began, work on the process was curtailed until Francis I. du Pont and William du Pont sponsored the continuance of the development in 1919, and Mr. Moxham constructed a pilot plant which was not altogether successful. Due to the then prevailing low prices for concentrates and to the inability of the process to operate at the low cost expected, work on the development practically came to an end. Unfortunately, Mr. Moxham died in 1922, and the research was brought to a standstill.

Early in 1927, Adrian Nagelvoort, who had been associated with Mr. Moxham in the last development, went to the Delaware Chemical Engineering Company, the laboratories of

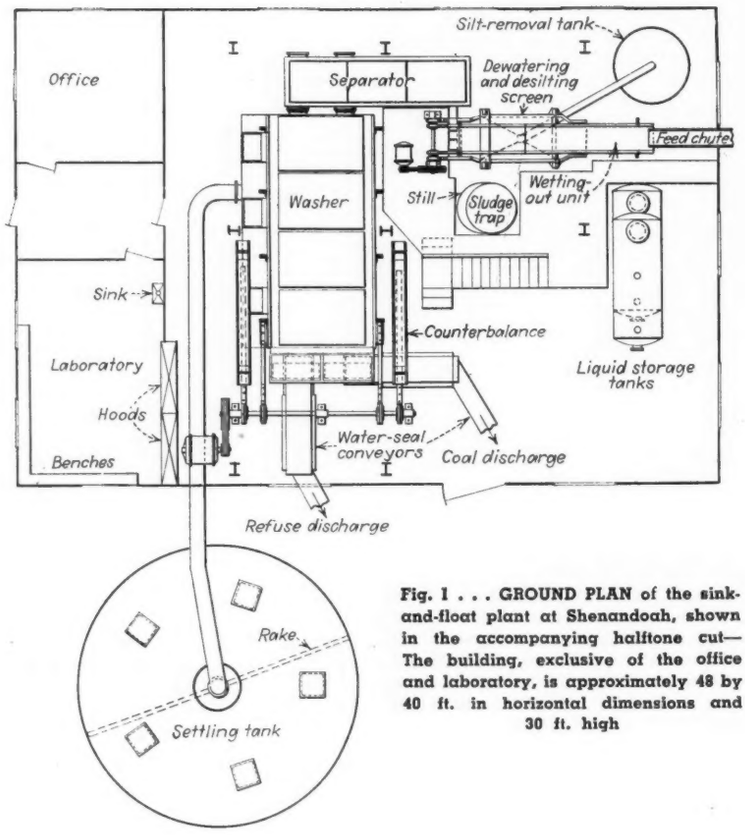


Fig. 1 . . . GROUND PLAN of the sink-and-float plant at Shenandoah, shown in the accompanying halftone cut—The building, exclusive of the office and laboratory, is approximately 48 by 40 ft. in horizontal dimensions and 30 ft. high

Francis I. and Alfred I. du Pont. Mr. Nagelvoort induced these gentlemen to resume research along the lines of development they had been following in the past and with which he was familiar due to his association with Mr. Moxham.

By this time, the art had developed to such a stage that it was apparent any heavy-gravity liquid which would be suitable for sink-and-float separation should have the following general characteristics: Specific gravity of at least 1.3 to 3; low vapor pressure at working temperatures; low melting point; minimum miscibility with water; stability towards water, air, light, and heat; freedom from any tendency to emulsify with water; approximately the same viscosity as water; good mobility at working temperatures, and, lastly, a low cost. Of the above requirements, it was believed that the most important was that of minimum miscibility with water in both phases, as any heavy-gravity liquid in which water is soluble would, of course, decrease in specific gravity from use, and means would then have to be provided to expel the water from the liquid to return it to its proper specific gravity; and any such liquid which is soluble in water would result in increased liquid loss.

Mr. Moxham had believed that material reduction in liquid loss would be achieved by wetting the minerals with water prior to immersion in the liquid, providing it was not miscible with water. Mr. Nagelvoort discovered that the application to the solid of a film of any liquid not miscible with the heavy-gravity liquid considerably altered the effective gravity of the solid and made possible the use of cheaper liquids.

The investigators decided that the heavy-gravity liquids at hand, the halogenated hydrocarbons, as represented by tetrabromethane ($C_2H_2Br_4$), specific gravity 2.964; pentachlorethane (C_2HCl_5), specific gravity 1.678; and trichlorethylene (C_2HCl_3), specific gravity 1.462 at 20 deg. C.-4 deg. C., should be considered the standard "Parting Liquids."[1] In the definition of the ideal liquid given previously, low miscibility with water was stressed as being of the utmost importance. This property is shared by the halogenated hydrocarbons used as heavy-gravity liquids. However, although classed as insoluble in water by the handbooks, it should be noted that these liquids do have a measurable solubility in water, that for pentachlorethane, for example, being approximately 5 parts per 10,000 at ordinary temperatures. The solubility of water in pentachlorethane is negligible.

As it was probable that the specific gravities at which these heavy liquids were manufactured would not be those required in actual practice, it was decided to procure the desired gravity by mixing any two of those named in proper proportion, or by diluting them with a suitable petroleum distillate.

As "Parting Liquids" having the proper characteristics were available in sufficient quantity, the development revolved around the ability of the organization to develop a commercial process and apparatus adaptable to the use of halogenated hydrocarbons as the separating medium. A number of different types of apparatus were constructed, and although satisfactory separations were made from the standpoint of the final concentrate, liquid losses continued to be excessive and the equipment was unsuitable mechanically.

In 1930, the author became associated with the Delaware Chemical Engineering Company. In that same year Charles W. Lotz, assistant consulting engineer of the M. A. Hanna Company, also joined the organization and perfected the mechanical operation of the pilot plants. On the basis of this work, the M. A. Hanna Company installed a commercial unit at the Pennsylvania colliery of the Susquehanna Collieries Company. The mechanical engineering on this unit was done by E. B. Worthington, mechanical engineer of Susquehanna, in consultation with Mr. Lotz and R. S. Walker, chief consultant of the Hanna company. This unit functioned perfectly in every way from the mechanical standpoint, as was to be expected, and the product was of premium quality, the separation being as perfect as that made in a laboratory sink-and-float apparatus. Unfortunately, after a fair tonnage of coal had passed through the unit, it was found that the loss of heavy liquid was so excessive, and the vapors escaping into the plant were so hazardous for the workmen, that the process as developed, although providing a perfect mechanical separation, was not commercially practical; therefore, the operation was immediately discontinued and the equipment dismantled.

It was apparent that unless something was done to eliminate the imperfections of the process, it could not be used and the money spent in its development would be wasted. Work was continued in the laboratory of the Delaware Chemical Engineering Company, and H. L. Alexander, a chemist of the staff, in collaboration with Hubert I. du Pont and the author, discovered a fact which is chemically new and which turned an otherwise complete failure into a successful process. This discovery, in two words, is "Active Agents,"[2] surface active substances which immunize the solids against the "Parting Liquids."

A vapor-tight test machine was immediately built. It had a capacity of approximately 10 tons of feed per

[1] The term "Parting Liquid" is a registered trademark.
[2] "Active Agent" is also a registered trademark.

hour. A number of extended test runs were made using active agents, the process was proved, and the liquid loss was reduced far below the requirements for commercial operation. The chemical engineering design of this unit was done by Francis I. du Pont and Hubert I. du Pont.

After the demonstration of this unit, the exclusive rights for the process were acquired by E. I. du Pont de Nemours & Company, Inc., which proceeded to carry the development to actual commercial operation.

A commercial plant was immediately designed and installed adjacent to the Weston colliery of the Weston Coal Company at Shenandoah, Pa., in the anthracite coal fields. Fabrication and erection were carried out by the Connery Construction Company, of Philadelphia. The author wishes to thank T. M. Dodson and B. Helm Stockett, of Weston, Dodson & Company, Inc., for cooperation and help during the evaluation of the process.

Arrangements were made to carry feed from the breaker's preliminary sizing screens into the sink-and-float plant. By this method, the feed to the latter can be any size or a mixture of sizes of run-of-mine coal that may be required for the test to be made.

Provision was also made to handle refuse from other collieries. This refuse is delivered in railroad cars to the breaker's condemned coal elevator boot. It is then carried into the breaker, over the preliminary sizing screens if desired, and thence to the sink-and-float plant. Other minerals and coal can be handled in the same manner.

The finished product from the sink-and-float plant is conveyed back into the breaker, where it is sized on the usual shaking-type final sizing screens. The loading pockets in the breaker are divided so that the product from the sink-and-float plant is not mixed with the products of the jigs and tables. This permitted the sale of the sink-and-float product as produced, without contamination, so that an evaluation from the ultimate user's standpoint was made of perfectly cleaned coal.

The refuse from the sink-and-float plant is conveyed to the breaker refuse pocket, where it is picked up by a breaker lorry and sent to the refuse bank with the regular colliery refuse.

The plant was put in operation April 6, 1936. By the middle of May, it was ready for continuous operation at a capacity of approximately 100 tons per hour. Subsequently, large tonnages of material in sizes from minus 3½-in. to plus 4-mesh were treated and extensive runs were made on the cleaned products and refuse from other types of equipment. At present, the plant is being kept intact and held available for running tests on large tonnages of coal or minerals.

The plant itself consists of a building approximately 48 x 40 ft. by 30 ft. high with a lean-to running the length of one end. This lean-to contains the office and laboratory. The ground plan is shown in Fig. 1. Close by is the completely equipped sample-preparation laboratory, where sink-and-float tests are made on the daily samples from the plant, after which these samples are crushed and tested for ash, moisture, ash fusion temperatures, etc. During operation, samples are taken of the feed, the product, and the refuse, and daily tests on all three fractions are made, the sampling being carried on at suitable intervals according to the tests being run and the information desired.

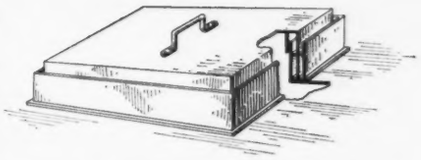


Fig. 3 . . . SEALING of the toxic vapors is accomplished by means of water seals on all equipment in which parting liquid is used. The construction of this seal is illustrated here

Innumerable tests were made and a great mass of data regarding the function and operation of each unit in the process was gathered by the technical staff, consisting of seven mining engineers, six chemists, and one chemical engineer. Four plant men—viz., a master mechanic, a pipe fitter, two operators, and one clerk—were attached to the staff.

In considering the equipment itself, reference can be made to Fig. 2. In the first step of the process, the coal from the primary sizing screens in the breaker is delivered via a feed chute to the wetting-out section (1). Here the feed is treated with the active agents. After this treatment, it is passed over a dewatering and desilting screen (2). It is then sent into the parting liquid in the separator (3), where the separation is made. The feed is here divided into two fractions, "floats" and "sinks," which are taken by conveyors to the washer (4), where the entrained parting liquid is removed. From the washer, the separated and washed materials are passed into the water-seal conveyors (5). The floats are then conveyed to the final sizing screens in the breaker and the sinks to the refuse hopper. The water used in the washer (4) flows by gravity into the settling tank (6), where the parting liquid and silt are settled out and the water is recirculated through the washer. The silt and parting liquid collected in the bottom of the settling tank are pumped to the sludge trap (7), where the excess water is decanted; the concentrated sludge is then passed to the steam still (8) and a steam distillation made for recovering the heavy-gravity liquid associated with the silt. The distillate is condensed in condensers (9) and returned to the used liquid storage tank (10) for recirculation to the separator. Storage tank (11) is used for fresh liquid storage.

The wetting-out section (1) receives the sized feed delivered by the chute from the breaker. The quantity of feed is controlled by a sliding

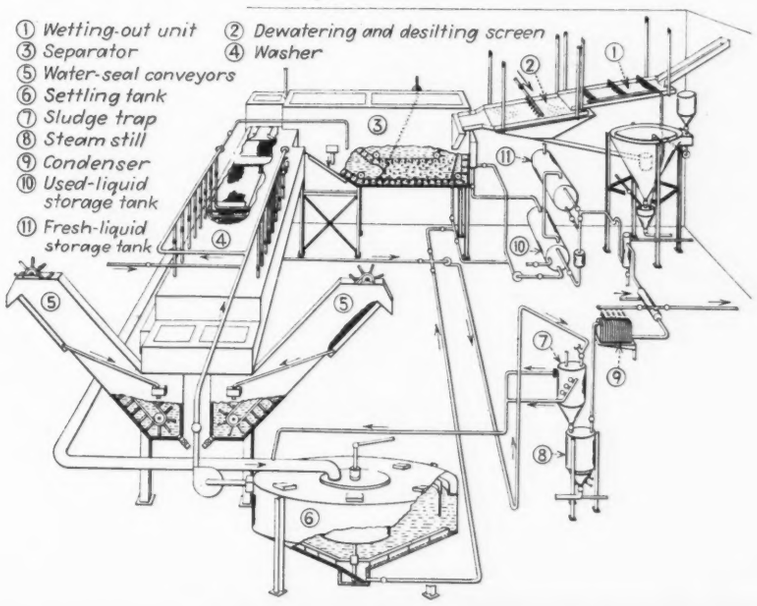


Fig. 2 . . THE FLOWSHEET of the sink-and-float process described in the text is clearly shown in this three-dimensional sketch

gate. After passing the gate, the feed is run onto a steel shaking trough or conveyor approximately 12 ft. long and 3 ft. wide and 12 in. deep. This trough is suspended on wooden slats and is given a reciprocating motion by means of the usual eccentrics and wooden drive arms. It has a downward slope of about $\frac{5}{8}$ in. to the foot. Above the deck are three banks of fish-tail sprays with ten fish-tails to the bank. These sprays are directed so that they drive into the feed passing down the trough, the material piling up in front of each bank. The horizontal motion of the trough pushes the material under each set of sprays, allowing the water to tear off the downstream side of the dam. By using this method, each particle is scrubbed thoroughly by the sprayed solution of active agent after being submerged in it. The sprays nearest the feed end of the deck are operated at approximately 5-lb. pressure, the next bank downstream at 3-lb., and the third at 1-lb. pressure. Under these conditions, approximately 180 gal. of active agent solution is sprayed over and into the feed per minute. The material being treated remains on the deck for approximately thirteen seconds.

It can be seen that the action of this wetting-out deck is to immerse the feed three times in a solution of active agent and to scrub it three times with a driving spray of the solution.

After "Wetting Out"

Material on leaving the wetting-out deck passes over a dewatering screen (2) approximately 4 ft. wide by 6 ft. long. The screen is suspended on wooden slats and is driven by eccentrics with wooden drive arms from the same shaft as that driving the wetting-out deck. The dewatering screen is used as a counterbalance for the wetting deck. On it the liberated silt and the most of the undersize are removed from the feed. The screen is dressed with a jacket having $\frac{1}{4}$-in. diameter round openings.

Fresh water for the system, approximately 12 g.p.m., is added through a bank of sprays placed halfway down the screen. It assists in removing the dirt, clay, or silt liberated from the feed by means of the action of the active agent solution. Tests have shown, when using the usual method of wetting—that is, spraying or submerging in water and then dewatering—that the surface moisture on pea coal is about 5 per cent. In practice, however, treatment in a solution of active agent raises the surface moisture to approximately $6\frac{1}{2}$ per cent. This increase in moisture is probably due to the active agent-water film completely surrounding each individual particle of material in the feed, leaving no bare or unwet surface. This aqueous film apparently remains intact on the surface of the particles throughout the process.

The active agent solution removed with the silt and make-up water through the perforations in the dewatering screen is passed to a conical settling tank. Here the silt is settled out of the solution, and the latter is brought to the proper strength by the addition of fresh solution. The solution is then recirculated to the wetting-out deck.

Silt and Clay Removed

It has been found that even though the run-of-mine product was scrubbed thoroughly in the breaker with fresh water, 10 to 15 lb. of silt and clay per ton of feed is removed by the action of the wetting-out deck assisted by the active agent. The importance of this will be realized as the description progresses. No attempt is made to reduce the percentage of solids recirculated from the cone below 2 per cent, inasmuch as these solids are exceedingly fine and are removed by the spray of fresh make-up water on the dewatering screen deck. A little water is added in excess of that actually required to wet the coal. This excess carries off part of the suspended solids amounting to approximately 3 lb. per ton of coal, so that the active agent solution never becomes a mud.

In considering the cost of the active agent for this step of the process, it has been found that a concentration of 0.01 per cent of starch acetate or tannic acid is satisfactory and that the cost per ton of feed for anthracite does not exceed $0.005.

The separating chamber (3) consists of a steel box, approximately 18 ft. 3 in. long, 3 ft. 8 in. wide, and 11 ft. 8 in. high, in which two flight conveyors are placed one inside the other. It contains a layer of the parting liquid superimposed by a layer of water. The depth of the heavy-gravity liquid is approximately 2 ft. and that of the water 2 ft. The feed chutes coming into the separator from the dewatering screen protrude into the water layer so that a vapor seal is formed. The chutes are arranged to distribute the feed evenly across the end of the machine in the water layer, and as the material drops through the water it fans out onto the surface of the heavy liquid. The heavy particles immediately plunge through the interface of the heavy liquid and the water and sink to the bottom, where they settle on the outside or sink conveyor. The floats either remain at the interface or after plunging into the heavy liquid a short distance, return to the interface, where they, in turn, are engaged by the inside or float conveyor. The middlings are trapped in the parting liquid.

The two conveyors run in the same direction, the outside removing the sinks upward over a wedge-wire screen which extends into the water layer, and the inside removing the floats in like manner over a similar screen. These screens have 3-mm. openings. Means, of course, must be provided to keep the floats and middlings from passing on to the sink conveyor; therefore, a baffle plate is placed between the two conveyor lines. This is V-shaped, the point of the V pointing against the direction of flow of the heavy liquid which is caused by the action of the conveyors. The apex of the V can be raised or lowered, and by this means the percentage of middlings in the floats or sinks can be controlled. The liquid which is pumped over and under this device by the flights on the conveyors is circulated, after passing through the wedge wire screens, around the outside of the separating chamber and then is returned to the chamber at the rear. In operation, the separated sinks and floats are continuously moved by the moving parting liquid from the portion of the separating chamber where the incoming feed enters the heavy liquid.

This eliminates rafting. Due to the rapidity of the separation, the separating area required per ton of feed product is exceedingly small. In fact, it has been found possible to operate this particular separator at tonnages up to 100 tons of feed per hour with an effective separating area of 2 sq. ft. of heavy liquid.

The level of the heavy liquid is maintained by pumping used liquid from the storage tanks into the separator. This makes up for the 5 to 10 lb. of liquid carried out of the separator per ton of coal or mineral separated. The volume filled by heavy liquid in the bottom of the separator is approximately 45 cu. ft.

The water level is maintained by pumping a continuous stream into the separator from the settling tank, the excess passing over a weir and back to the tank.

In the Washer

The washer (4) receives the sinks and floats after the sorting has been made, and they are withdrawn from the parting liquid in the separator by the conveyors through the water layer which tends to remove a large quantity of the entrained liquid. The two fractions are passed onto two shaking conveyors which are an integral part of the washer screen. This screen is approximately 20 ft. long and 8 ft. wide. It is hung on wooden slats through a specially designed water-seal and is driven by eccentrics. It is counterbalanced by two weights

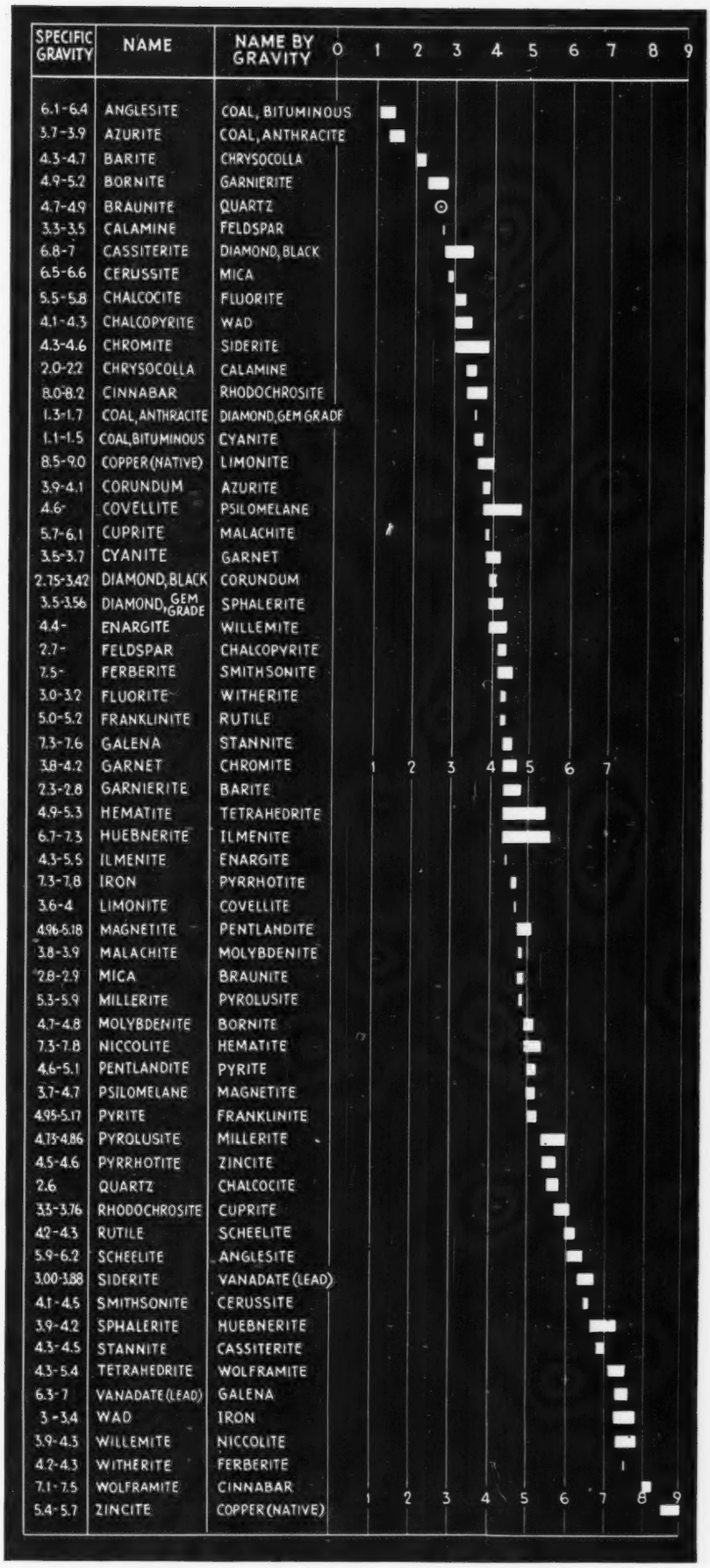


Fig. 4 . . . SPECIFIC GRAVITIES of 60 minerals, each in its known range of occurrence, are plotted at the right, thus showing the relationship of each mineral to the others in the scale, as well as the overlap, if any, of specific gravities of adjacent minerals

supported on wooden slats also driven by eccentrics. The screen is dressed with a perforated steel plate, the holes being about $\frac{3}{16}$ in. in diameter. It is operated at approximately 132 r.p.m. and has a 4-in. stroke. As it is not a sizing screen but really a dewatering conveyor, the high speeds required in normal screening operations are unnecessary. A partition, running the full length, is placed in the middle of the screen to keep the floats from becoming contaminated with the sinks.

Water Sprays for Scrubbing

Extending across each side of the screen are multiple, individually controlled sets of fish-tail sprays. Each set consists of twelve nozzles pointing almost vertically downward so that the water tends to dam up the floats and sinks as they are conveyed along each side of the screen. The horizontal motion of the screen pushes the fractions under each set of sprays, allowing the water to tear off the downstream side of the dam. This permits the thorough scrubbing of each individual particle, so that the entrained parting liquid, which has been kept away from the surface of the material due to the action of the water placed on it by the active agent, can be recovered. There is sufficient space between each set to permit a thorough dewatering from the previous wash. Immediately behind each set of sprays and hanging from the top of the housing is a baffle plate with a trough at its bottom. These catch the splash from the upstream spray and carry it and the splashed parting liquid off to the side of the housing. This is done so that the heavy liquid which may be driven off the material being washed will not be splashed the full length of the washer housing and contaminate the washed product.

Inasmuch as it was planned to treat a variety of coal and minerals in this plant, and as it was necessary that none of the products should carry excessive amounts of heavy liquid from the operation, ten sets of sprays were installed on each side of the washer screen. Operating experience on anthracite run-of-mine and refuse demonstrated that never more than five sets would be required to secure a minimum liquid loss. In practice, these five sets are operated at a pressure of approximately 8 lb. per square inch and wash the sinks and floats with 1,100 to 1,200 g.p.m. of recirculated water.

The water-seal conveyors (5) receive the material after it is thoroughly dewatered on the end of the washer screen. These conveyors are ordinary flight conveyors running in a boot so arranged that the feed from the washer screen is discharged into them through water, thereby forming an effective vapor seal. The sinks and

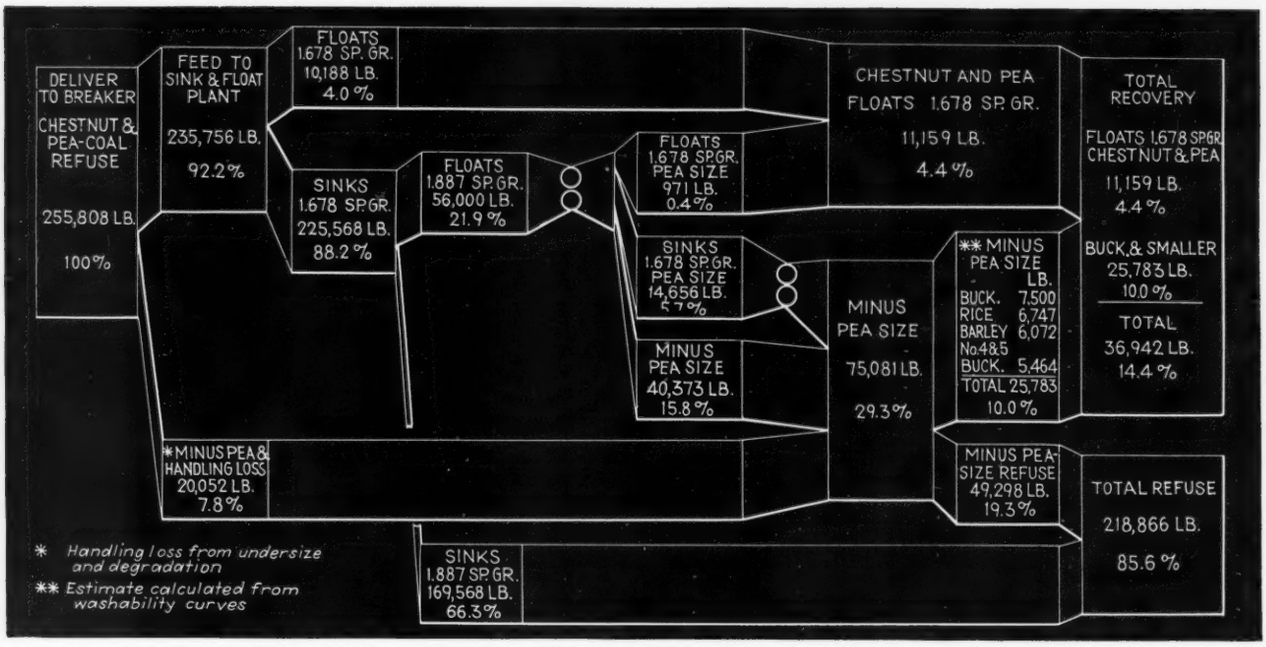


Fig. 5 . . . RESULTS of a test run on mixed anthracite refuse are shown here. They are considered indicative of the operation from the ore-dressing viewpoint, the heavy refuse representing the concentrate desired in the latter case

floats are then conveyed to the refuse hopper and the final sizing screens in the breaker.

The settling tank (6) is outside the building. It is approximately 25 ft. in diameter, 12 ft. high, and has a conical bottom with approximately a 10-deg. slope. In the bottom is the usual form of rake for moving solids into the center. The weir box at the top runs completely around the tank. Concentric with the weir there is a scum gutter which keeps small droplets of the heavy liquid from passing over the weir. At intervals along the bottom of the gutter, pipes are led to a point near the tank bottom, so that the heavy liquid caught in the gutter can run to the bottom and be kept out of the weir overflow.

Inasmuch as the heavy liquid has a high gravity, large droplets naturally settle to the bottom. The upward current in the tank carries some small droplets to the surface, where they immediately break and make a "slick" on the surface similar to that made by oil. The film forming the slick finally becomes so thick that it contracts and breaks into droplets sufficiently large to settle to the tank bottom.

Naturally, there is some degradation in the process. The degraded material is removed from the finished product through the washer screen and passes to the settling tank with the wash water. The droplets of heavy liquid falling through the water in the settling tank carry down the small solid particles and thus keep the percentage of solids in the recirculated water to the washer from the tank so low that it can be considered only a trace. It is due to this self-cleaning action and to the freedom from emulsification of the parting liquid when beaten into water that the settling tank can be made relatively small and operated continuously without building up a high percentage of mud or slime.

The water for the washer is pumped from the settling tank overflow by a centrifugal pump that has a capacity of 3,000 g.p.m. at a 52-ft. head. As stated before, it was not found necessary to use this quantity of water nor as high a spray pressure. In fact, the whole washing system was more than twice as big from the standpoint of pumping equipment, settling tank, number of sprays, etc., as was required. The screen deck proved to be of ample size for the tonnages handled.

The sludge trap (7) receives the underflow from the settling tank. A centrifugal pump is used to move this mixture of parting liquid, silt, and water through ordinary pipe lines to the trap. The sludge trap itself consists of a straight-sided tank 4 ft. in diameter and 6 ft. high, with a conical bottom. It has a small overflow weir around the top and is fitted with fresh-water stingers at the bottom to break up bridging of the settled solids when they are discharged.

Pumping the Underflow

The pump drawing on the underflow of the settling tank is operated so that the settling time in the trap is longer than that in the main tank. This assures the settling of the heavy liquid and solids to the bottom of the trap. The entrained water flows over the weir and returns to the settling tank. When the trap is about half full of solids, the pump is stopped and, after five or ten minutes, the water remaining on top of the settled solids and the parting liquid is decanted to the settling tank. After the water has been decanted, the heavy liquid and solids are dropped through the bottom of the trap into the steam still immediately below. The pump connected with the underflow of the settling tank is subsequently started and the trap receives a new charge.

The steam still (8) placed immediately below the sludge trap is also 4 ft. in diameter and 6 ft. high. It has a conical bottom and is fitted with water stingers. The still is steam-jacketed around the sides and bottom and has five steam nozzles in the bottom adjacent to the outlet. After sufficient charge has been dropped from the sludge trap to fill the still approximately three-fourths full of solids and parting liquids, the distillation is made. Steam consumption varied from 1.1 to 5.8 lb. per pound of liquid recovered. The steam consumption varies with the composition of the charge to the still and also depends to a large extent upon the time required for stripping the last traces of parting liquid from the solids present. When the distillation is completed, the solids discharged from the still contain 0.01 to 0.02 per cent of the heavy liquid by weight.

The distillate from the still is passed through the usual form of atmospheric drip-type condenser (9) on the roof of the plant, about 2.7 gal. of water being used for each pound of steam added to the still. The condensate is passed through a cooler and water separator. The recovered parting liquid is sent to the used-liquor storage tank and the water to the settling tank.

When running the plant at maximum capacity for the usual 8-hr. shift,

it was *unnecessary* to make more than one distillation, since, due to the action of the active agent, the desilting was so complete and the quantity of heavy liquid removed from the separator so small that only a very small quantity of material was collected in the settling tank. This, in itself, shows that the generation of fines in the process is practically nil, as at no time did the silt distilled exceed one-half of 1 per cent of the cleaned coal produced. As the size of material handed increased, the quantity of silt was substantially reduced.

In its general construction, the machinery and apparatus used in the process are standard. All joints must be welded liquid- and vapor-tight. The material used is ordinary structural steel and plate with bronze screens in the separator. All pieces of inclosed apparatus are vented to each other and there is a common vent for the whole plant. Vapor sealing is accomplished by means of water-seals on all equipment in which the parting liquid is used (Fig. 3).

The water-seals consist of a U-shaped member not less than 6 in. deep filled with water; the lid for the apparatus is so made that its edge sits in the water, thereby forming the seal. This method of construction alleviates the necessity for bolts, toggles, and other usual methods for holding lids and covers on equipment where it is desired to keep them vapor-tight.

There are two reasons for the water-seal: First, the necessity of preventing the escape of the heavy liquid vapor, as all parting liquids are more or less volatile and the losses resulting if the apparatus is not sealed would make the process inoperable from a commercial standpoint; the second reason is the toxicity of the liquids.

This toxicity is well recognized. The liquids, like all halogenated hydrocarbons, are toxic if taken into the human system by inhalation, absorption through the skin, or otherwise, and at high temperatures they tend to decompose with the formation of toxic compounds. However, the potential health hazard involved in the operation and maintenance of the equipment can be eliminated if suitable precautions are taken to prevent (1) exposure of human beings to heavy liquids or their vapors; and (2) exposure of these materials in either the liquid or vapor form to high temperatures such as occur in open flames and electric welding ares.

Table I—Parting Liquid Loss. Run No. 12

Feed and production			Tons
Feed (run-of-mine pea coal)			3,090
Coal produced			2,445
Refuse			611
Silt removed in wetting section			18
Silt discharged from still			16
Operating losses	Lb.	Oz. per Ton Cleaned Coal	Per Cent of Overall Loss
Loss on coal	796	5.2	44.5
Loss on slate	120	0.8	6.7
Distillation loss	286	1.9	15.9
Saturated water, vapar loss, etc.	53	0.3	2.9
Total operating loss	1,255	8.2	70.0
Clean-up losses			
Settling tank full of saturated water	220	1.4	12.2
Additional loss in pumping out settling tank	197	1.3	11.0
Vapor losses	14	0.1	0.8
Total clean-up losses	431	2.8	24.0
Unaccounted-for loss			
Total unaccounted for	107	0.7	6.0
Over-all loss			
Over-all loss	1,793	11.7	100

Some Safety Precautions

The following are the principal safety precautions taken in the operation and maintenance of the plant described:

The entire system is so constructed as to be liquid- and gas-tight. Water-seals are provided as described and shown in Fig. 3 to prevent the escape of vapors from the equipment.

To eliminate the potential health hazard involved if men entered the equipment for inspection or repair work, means are provided to replace with fresh air the air in the machinery which, of course, has become nearly saturated with the heavy parting liquid vapors. It is extremely dangerous for men to enter the machinery unless this precaution is taken.

All pockets, sumps, or low places are ventilated so as to prevent the accumulation in them of heavy liquid vapors, which, being heavier than air, would tend to collect in these places.

To prevent contact of the skin with the parting liquid, which might result in absorption of these materials into the system, all surfaces being worked on are washed with water and kerosene to remove even minute traces before any repair work is done. This precaution is also taken before a torch or welding arc is applied to any surface to prevent subjecting the liquid to high temperatures.

The small quantity of heavy liquid which may be left on the material leaving the plant does not introduce a health hazard, inasmuch as it does not remain on the material.

Fire hazard is nil, the halogenated hydrocarbons being non-flammable materials, some of which are extensively used in other industrial processes where this particular property is of primary importance.

Parting liquid loss per ton of feed was determined by making a number of quantitative runs. The method used in procuring accurate quantitative results was to empty the plant completely of all saturated water, parting liquid and active agent solution. The plant was then recharged, actual weights being kept of the parting liquid as it was charged into the separator and used-liquid storage tank. At the end of each run, all the available free liquid was removed from the equipment and weighed. The over-all loss per ton of cleaned coal was secured by subtracting the liquid recovered from the liquid charged and dividing the remainder by the tonnage of coal shipped. The breakdown of the losses was procured from the laboratory tests carried on throughout the run. A typical example, Run No. 12, is shown in Table I.

It should be pointed out that the clean-up loss of 2.8 oz. per ton would be non-recurring in regular operation, as it would be unnecessary to remove the saturated water from the settling tank, the vapor losses through venting of the machines and equipment would be unnecessary, and the loss due to the pumping of the settling tank would be eliminated.

By subtracting the non-recurring loss of 2.8 oz. per ton from the over-all loss of 11.7 oz. per ton, it is found that the actual operating loss for the run was 8.9 oz. per ton of cleaned coal. In applying this figure to material of a size different from that of anthracite pea coal, it must be remembered that the parting liquid loss increases as the size of the particles sorted decreases and that the loss decreases as the size of the particle increases. No set formula has been derived to calculate this variation in loss. The highest

(*Continued on page 48*)

Table II—Condemned Coal and Reasons for Condemning

Date	*Number of R. R. Cars*	*Size*	*Reason*
5/20/36	2	Pea	Oversize
6/18/36	1	Nut	Flat coal (appearance)
6/23/36	¼	Nut	Undersize
6/26/36	2	Nut	Slate and bone(*a*)
6/29/36	1	Nut	Light bone and flats(*a*)
6/30/36	1	Nut	Flat coal (appearance)
7/14/36	2	Nut	Flats and rock(*a*)
7/24/36	2	Pea	Rock
7/31/36	1	Pea and nut	Bone (appearance) (*a*)
8/17/36	1	Pea	Yellow, light-gravity rock(*a*)
8/29/36	1	No. 1 Buckwheat	Too high ash
9/ 1/36	1	Rice	Too high ash
10/22/36	1	Pea	Light round stones(*a*)
10/24/36	1	Pea	12 per cent sinks
11/27/36	1	Pea	Wood and rusty coal
4/ 8/37	¼	Pea	Light stones(*a*)
4/12/37	1	Pea	Dirt and light stones(*a*)
	19¾		

(*a*) Mainly floats on 1.75 specific gravity zinc chloride.

Bucket Dredge Installed

At Goodnews Bay, Alaska

New pontoon-type boat, replacing dragline, began recovering platinum Nov. 10, eight months after contract was awarded

H. A. Sawin
Yuba Manufacturing Company
San Francisco, Calif.

GOVERNMENT geologists several years ago discovered traces of platinum deposits on rivers emptying into Goodnews Bay, an arm of Bristol Bay, Alaska. Goodnews Bay Mining Company was formed by several Alaskans of varying mining experience, and after taking up claims in the Goodnews Bay area they worked for two seasons on Squirrel Creek with dragline dredging units, mining metals of the platinum group.

As the potential value of the deposits became established and their extent better known, dredging with bucket-line equipment on Salmon River was proposed. After consulting with dredge designers and builders, an order was placed with Yuba Manufacturing Company, of San Francisco, for an 8-cu.ft. steel pontoon-type dredge, capable of digging 50 ft. below water level and having a total weight of about 1,400 tons. Financial assistance was secured through the R.F.C., and a contract was awarded to Yuba Manufacturing Company on March 15, 1937, providing that the dredge should be erected and ready to operate on or before Nov. 15, 1937.

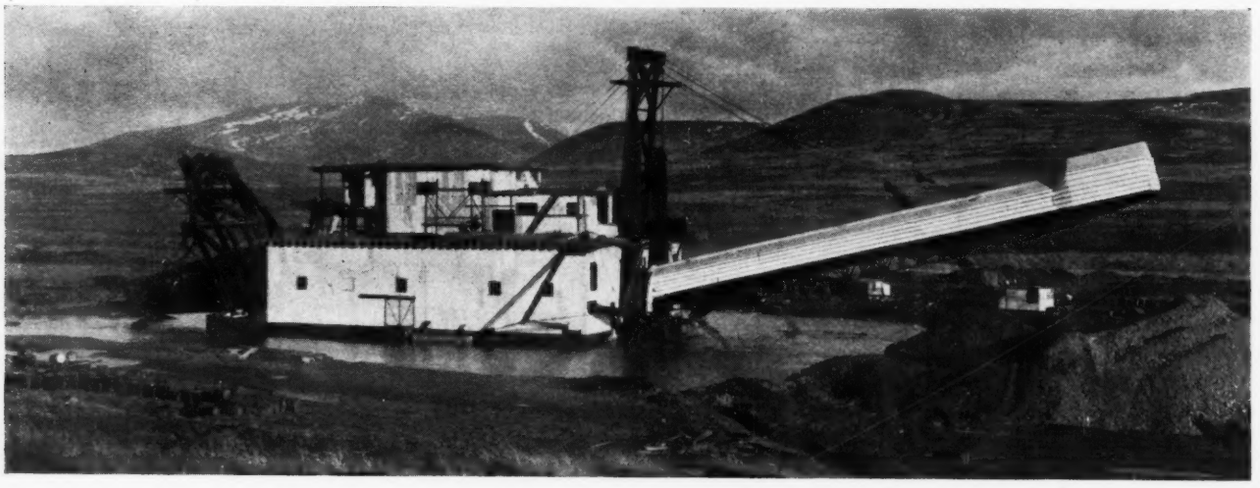
Consolidating the complete equipment, including pontoons for the hull and steel superstructure, shipment was made from Alameda, Calif., on Aug. 6, 1937. The Alaska Steamship Company's S.S. "La Touche" was chartered for the trip to Platinum Spit, Alaska, but due to last-minute complications involving inspection of the cargo, it was necessary to leave behind six of the pontoons and several hundred barrels of fuel oil. Special arrangements were made to ship these materials by boat to Seattle, from which point they were forwarded by regular steamer to Dutch Harbor, Alaska, to be picked up later and brought to Platinum Spit.

Building of this dredge, using a pontoon-type hull, has again demonstrated the practicability of such equipment. The first Yuba pontoon-type hull was built in 1933 for use in Montana. Since then the company has manufactured thirteen dredges of this type, including the original hull. Construction of the pontoons has undergone constant improvement, and the results attained have proved conclusively that such hulls, when properly constructed, provide strength and utility at least equal and perhaps superior to standard-type hulls. In addition, employment of multiple watertight compartments in the construction of the hull increases materially the safety factor of dredges equipped with such units.

To most people it might appear to be a hopeless situation to have 1,400 tons of miscellaneous machinery and structural steel dumped on a remote beach in Alaska during the first week of September with the prospect of hauling the material 20 miles by tractor for reassemblage and have the dredge operating by Nov. 15. Twelve miles of the haulage was along the beach and 8 miles along the Salmon River, using the river bed for a roadway and at times hauling in water 2 ft. deep.

Because of good management in shipping the parts, and the organizing ability of the superintendent and his assistants on the ground, the dredge actually was placed in operation on Nov. 6. After the dredge was floating and had started to dig, the pond water was lost accidentally, thus postponing the starting date to Nov. 10. The dredge mined platinum for 41 days

THE NEW DREDGE, on Salmon River, in the Goodnews Bay district, Alaska. The buckets are of 8-cu.ft. capacity. Both stacker and digging ladders are covered and heated to permit sub-zero operation

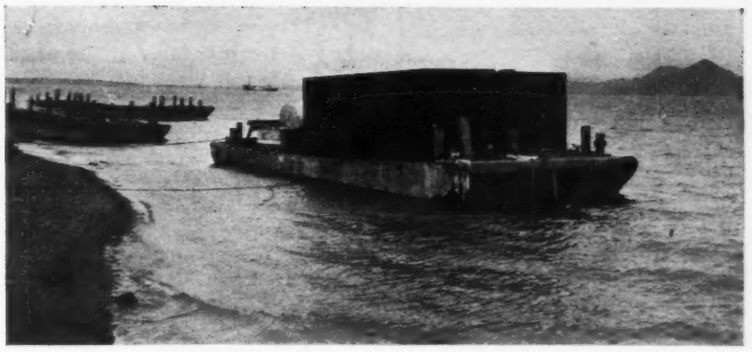


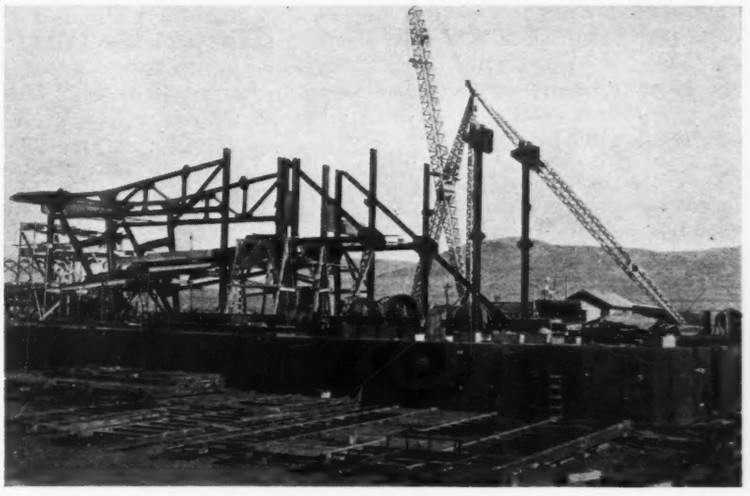
before being shut down to conserve fuel oil, permitting operations to start again early next spring before the new shipment of fuel oil could arrive on the ground.

Among the difficulties encountered were such matters as tractors and trailer loads being abandoned temporarily on the beach during high tides, and tractors and loads being stalled on many occasions in the stream bed. The pontoons were shipped from California fully fabricated and had only to be bolted in place in the pit provided for the erection of the dredge. No compressors were required at the erection site, as the pontoons, superstructure, and machinery were bolted together instead of riveted. To expedite work many units of the dredge, as well as siding for the dredge housing, were fabricated on the bank and erected in sections. A high wind created a constant hazard in erection, and later the inconveniences and discomfort of snow were added to the problems that the construction crew already had.

Planes for Transport

Many employees on the construction job traveled to and from the site by plane, which was the only means of transportation, as the landing point for steamers was some 20 miles distant. All freight had to be lightered from the ocean carrier because of shoal water, and the material thus moved could be unloaded from the lighters at high tide only.





LIGHTERING PONTOONS (above) from the steamer on their arrival at Platinum Spit, Alaska. Shipment was made from Alameda, Calif. The lower illustration shows the sectionalized hull five days after setting the last pontoon. In dimensions it is 130 ft. long, 60 ft. wide, 9½ ft. high. It is composed of 33 steel pontoons

The dredge has a pontoon-type hull, as mentioned previously, which measures 130 ft. in length, 60 ft. in width, and 9 ft. 6 in. in depth, and is composed of 33 steel pontoons. This gives the dredge about 3 ft. of freeboard when operating with the digging ladder in a position to dig 25 ft. below water and with 15,000 gal. of fuel oil in the hull pontoons tanks provided for this purpose. All pontoons are electrically welded for strength and watertightness, continuous welds being made where necessary to close outside seams. Reinforcing is built into the pontoons for machinery foundations, and for footings for trusses and gantries. The house frame is of steel which is covered with corrugated galvanized sheets outside and ¼-in. fiber and flat galvanized sheets inside.

The 8-cu.ft. manganese-steel buckets were furnished by Taylor-Wharton Iron & Steel Company. Bucket pins are 5⅜-in. in diameter made from Yuba nickel-chrome steel. The lower tumbler is of manganese steel and of the two-piece type; the upper tumbler is a one-piece high carbon chrome-steel casting provided with forged heat-treated nickel-chrome steel wearing plates.

In this dredge the digging ladder is 112 ft. long, to provide a digging depth of 50 ft. below water level when operated at 45 deg. to the horizontal. The main drive is of the double-train type with two bull gears, each 14 ft. in diameter and 10-in. face. A V-belt drive is used for transmitting power from the main drive motor to the pulley shaft. The revolving screen is 7 ft. 6 in. in diameter and has a perforated section 26 ft. long. It is driven from the lower end by a single roller and, in addition, is provided with a V-belt drive from the motor.

An independent ladder hoist winch is situated on the starboard side of the dredge. Here also is the swing winch, containing eight drums. The bow swing-line drums can be operated independently of the other drums. A motor aft of the upper tumbler actuates the bucket line through a V-belt drive. The stacker ladder is 140 ft. long center to center, and is covered and heated, as is the digging ladder, to permit operation in sub-zero weather. On it operates a 36-in. rubber and canvas belt made by the American Rubber Company, and power from the motor on the outer end of the stacker is transmitted by a V-belt drive.

The steel tables are built with the conventional side and tail sluices using wooden Hungarian, rubber-shod riffles. The tables are so arranged and of such width as to permit installation of jigs should this be found desirable. As built, the equipment includes a Pan-American placer-jig testing unit consisting of two 42x42-in. end-flow cells, and a 12x12-in. pulsator jig. Power for the dredge is supplied by a McIntosh-Seymour Westinghouse diesel-electric generator built by the American Locomotive Company and rated at 625 kva. This unit is installed on the dredge. The total of the installed load amounts to 600 hp.

The dredge was designed under the direction of Walter B. Macaulay, chief engineer for Yuba Manufacturing Company, from specifications prepared by the owner's consultant, Harry G. Peake. W. F. Crown, superintendent for Goodnews Bay Mining Company, erected the dredge in Alaska, with Charles Deaver representing Yuba Manufacturing Company in an advisory capacity. Charles Herbert represented the Federal Reconstruction Finance Corporation, inspecting the work throughout its progress and the completed dredge.

Pulp Density As a Factor in Flotation

Further data obtained from studies made on three base metal ores

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IN A PREVIOUS PAPER[1] data were reported dealing with the effect of pulp density on the flotation of gold ores. The conclusions reached were as follows:

1. *Gold recovery was increased with increasing pulp dilution.*
2. *Flotation rate, in grams per minute, increased with increasing pulp dilution.*
3. *Quality of concentrate, and, in turn, the ratio of concentration increased with increasing dilution.*
4. *With xanthate concentrate constant, in respect to the water, recovery decreased with increase in pulp density, and the concentration ratio increased with pulp dilution.*

The data given in the present paper were obtained by a study of the effect of pulp density on the flotation of three base-metal ores; the technique used was as nearly as possible the same as that used in testing the gold ores.[2] Flotation tests were made on a lead ore, a copper ore, and a zinc ore, described as follows:

1. *Lead Ore*—This was an argentiferous galena ore, and was a sample of the mill heads for the West Mill of the Bunker Hill & Sullivan Mining & Concentrating Company. A preliminary assay of this sample gave the following: Lead, 9.0 per cent; zinc, 0.9; silver, 3.9 oz. per ton; and gold, a trace. Specific gravity was 3.51.

2. *Copper Ore*—The copper ore used was a sample of the deslimed sand feed (minus 1½ mm.) delivered to the main flotation plant of the Anaconda Copper Mining Company, at Anaconda, Mont. The sample received assayed 6.1 per cent copper. Average[3] composition of this ore will be about as follows: Copper, 4.20 per cent; iron, 11.0; sulphur, 13.3; SiO_2, 57.7; Al_2O_3, 7.7; CaO, 0.6; silver, 2.0 oz. per ton; and gold, 0.01 oz. per ton. The specific gravity of this sample was 3.38.

3. *Zinc Ore*—A lead-free zinc ore of the proper grade was not at hand, so an artificial zinc ore was made up. A sample of hand-picked high-grade ore was available from the mine of the Pend Oreille Mines & Metals Company, Metaline Falls, Wash., which assayed as follows: Zinc, 32.1 per cent; lead, 0.2; and silver, 0.2 oz. per ton.

This high-grade ore was crushed to minus 6 mesh and diluted with three times its weight of barren quartz. The resultant mixture assayed 8.0 per cent zinc and had a specific gravity of 2.80. The term "zinc ore" as used in all subsequent discussion will refer to this mixture of quartz and high-grade.

Grinding—Both the lead and zinc ores were crushed to minus 6 mesh before grinding; the copper ore was fine enough to go directly to the ball mill. As in the case of the previous tests[4] on gold ores, dry grinding was used. The ores were ground in 2,000-gram batches in a steel ball mill 11 in. in diameter by 9½ in. long, containing a ball charge weighing 25.6 kg. This mill rotated at a constant speed of 68 r.p.m. The lead ore was ground for 18 minutes and the plus-14-mesh material was removed and added to the next batch of ore charged to the ball mill. Copper ore was ground 15 minutes and separated at 48 mesh. Zinc ore was ground 15 minutes and separated at 28 mesh. In each case, several batches were ground in succession until a stock of ground ore sufficient for all of the flotation tests on that particular ore had been obtained. The feed for each flotation test was then weighed out as needed.

In Table I is a summary of the screen analyses of the three ores after dry grinding:

Flotation Technique—Flotation tests were performed in two Denver Sub-A (Fahrenwald) testing cells. The larger (2,000-gram) machine held 8,640 c.c. of pulp and the smaller (500-gram) had a capacity of 2,400 c.c. All tests were batch tests, and each charge of ore and water was made up so that the pulp had (1) the proper density, and (2) a total volume equal to the capacity of the cell. The smaller flotation cell was used in most of the tests.

Ore and water were first added to the cell and then allowed to condition for a certain period before the froth was removed. The exact schedule followed in each case will be given later. Froth was usually removed for 6 minutes, then a second froth was removed for the next 6-minute period, and a third froth for the last 6 minutes. Each of the concentrates was weighed and assayed, and the over-all recovery for the 18 minutes of frothing was calculated from the weights and assays of the three fractional concentrates. When time of frothing was variable, a fourth fractional concentrate was taken for whatever time was required. To illustrate: If it were desired to remove froth for 53 minutes and 5 seconds in a particular test, there would be three 6-minute froths for a total of 18 minutes, and the fourth froth would be raked for 35 minutes and 5 seconds. The exact time of frothing for each test will be given in the tabulations which follow.

Flotation of Lead Ore—Table II gives the results of the group of eight tests which form Series I. Reagents used were pentasol xanthate (Great Western Z-6), 0.05 lb. per ton of ore; pine oil, 2 drops per test (0.015 gram), and Na_2CO_3, 0.25 gram per test. The amount of xanthate used was calculated for each test from the amount of ore used. The amounts of Na_2CO_3 and pine oil were the same in each case. After the ore and water had been added to the machine, the Na_2CO_3 and xanthate were added and the pulp was allowed to condition for 3 minutes.

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* In cooperation with Idaho Bureau of Mines and Geology, 1936-37.

[1] A. W. Fahrenwald, Joseph Newton, and Patrick L. McManus: "Pulp Density as a Factor in Flotation of Gold Ores." *Eng. and Min. Jour.*, Vol. 137, No. 11, pp. 552-554, November, 1936.

[2] *Ibid.*

[3] B. S. Morrow: "Both Copper and Zinc Ores Treated by Selective Flotation in Concentrators at Anaconda, Montana." *Eng. and Min. Jour.*, Vol. 128, No. 8, pp. 295-300, August, 1919.

[4] A. W. Fahrenwald, et al. *Op. cit.*

Then the pine oil was added, the air turned on, and the pulp allowed to condition for another 3 minutes. At the end of the second conditioning period, the froth was raked for 6 minutes. The same frothing time was used for all of the tests in Series I.

Series II (Table III) is identical with Series I except that froth was removed for 18 minutes in a series of three 6-minute concentrates. Since the silver seemed to follow the lead quite closely, the products in Series II and all following tests were assayed for lead only, and the recoveries were calculated on the basis of the lead.

The tests in Series I and Series II show that there is an appreciable drop in recovery at higher pulp densities, particularly in the range of 20 to 40 per cent solids. Recovery in the range 5 to 20 per cent solids is fairly constant. The ratio of concentration does not show much variation, and in general the ratio of concentration is high for low recoveries and low for high recoveries, as might be expected. Decreased recovery at high pulp density is in general agreement with the previous results obtained on the flotation of gold ores.[5]

In the tests at high pulp density there is considerably more ore in the flotation cell than in the low-density tests, and it seemed possible that a longer frothing period should be allowed for the high-density tests—perhaps the low recoveries at high pulp density were due simply to insufficient frothing time. To find an answer to this question, the data in Series III (Table IV) were collected.

In the last three tests of this series, the frothing time was made proportional to the weight of the heads on the assumption that 6 minutes represented the correct frothing time for the most dilute pulp (5 per cent solids). The first two concentrates were raked for 6 minutes each; the third concentrate was raked for the time required to give the proper total. The amounts of reagents used and the conditioning periods are the same as in Series I and Series II.

Results in Table IV show that there is a pronounced drop in recovery for high pulp densities even though a much longer frothing period is used than was used in Series I and Series II. Comparison of test No. 18 (Table III) with test No. 28 (Table IV) shows that for a pulp containing 40 per cent solids the recovery was increased only 1.1 per cent (from 81.6 to 82.7 per cent) when the frothing time was increased from 18 minutes to over an hour (64.7 minutes). Apparently, then, the decrease in recovery in high pulp densities cannot be attributed to insufficient frothing time.

Comparison of the data in Table IV with Tables II and III shows that the necessary frothing time is by no means proportional to the weight of ore in the cell. For example, the total recovery (18 minutes frothing) is practically the same in the first four tests (Nos. 11, 12, 13, and 14) in Series II (Table III), even though there is much more ore used in test No. 14 (560.2 grams) than in test No. 11 (124.6 grams). It is possible that under certain conditions the capacity of a flotation cell might be increased considerably by using a higher pulp density, because the weight of ore in the cell could be increased three- or fourfold without affecting the percentage recovery obtained in a given frothing period. This point is illustrated even more strikingly by the data on the flotation of the copper and zinc ores, as we shall see presently.

In the previous tests on gold ores[6] it was found that the recovery was greatest at the lowest pulp density tested (11.2 per cent solids) and the indications were that the maximum recovery might be found at still lower pulp densities. In the flotation of the lead ore, however, the recovery was practically constant in the range 5 per cent to 20 per cent solids. It was thought that perhaps greater recoveries might be obtained at lower pulp densities by the use of more xanthate, inasmuch as, although the same weight of xanthate per ton of ore was used in the tests in Series I, II, and III, the relatively high dilution of the xanthate in the low-density pulps might make it less effective. Accordingly, several tests were made (Series IV) in which the same amount of xanthate was used in each test; this was the amount which was equivalent to 0.05 pound per ton of ore in a pulp containing 20 per cent solids. The results of these tests are given in Table V. Three 6-minute froths (total 18 minutes) were taken so that the data are comparable with those in Table III.

Comparison of Series IV with the first four tests in Series II shows a slight increase in recovery with the maximum at about 10 per cent solids. Apparently the concentration of xanthate in the liquid has some effect on its collecting properties, and the amount of xanthate expressed as pounds per ton of ore is not the whole story.

Flotation of Zinc Ore—Table VI gives the results obtained from the flotation tests made on the zinc ore. The reagents used in these tests were as follows: Na_2CO_3, 0.25 gram per test; $CuSO_4.5H_2O$, 0.50 lb. per ton of ore; pentasol xanthate, 0.10 lb. per ton of ore; and pine oil, 4 drops (0.03 gram) per test. The ore pulp was first agitated for 3 minutes with the Na_2CO_3 and $CuSO_4.5H_2O$, then the xanthate was added and the pulp allowed to condition for 3 minutes more. Finally the pine oil was added, the air turned on, and the pulp agitated for the third 3-minute period. Froth was then collected in four froths. The first three froths were collected for 6 minutes each and the fourth froth for the time required to make the frothing time proportional to the amount of ore in the machine. The second and third froths in test No. 61, and the third froth in test No. 62, were taken, although these were not required.

It will be noted that the results in Table VI differ widely from those given in Tables II, III, and IV. The recovery is quite high at first, drops to a minimum at 25 per cent solids, and then rises again to better than 99 per cent recovery at pulp dilutions of 35 and 40 per cent solids. This is not the type of behavior that would be expected if the effect were due simply to pulp density changes, and it is our opinion that the drop in recovery is due to changes in the concentration of $CuSO_4$ in the water of the pulp. Apparently the efficacy of $CuSO_4$ as a promoter for ZnS depends not only on the amount of $CuSO_4$ present per ton of ore, but also on the concentration of the $CuSO_4$ in the water; probably the latter factor is the more important. Test No. 69

Table I—Screen Analyses of Flotation Feed

Mesh	Lead Ore, %	Copper Ore, %	Zinc Ore, %
+ 48	0.6	0.0	7.0
−48 + 65	2.1	4.5	9.2
−65 + 100	6.8	12.0	12.7
−100 + 150	8.6	13.3	11.5
−150 + 200	15.9	14.6	13.6
−200	65.9	55.6	46.0

[5] A. W. Fahrenwald, *et al., op. cit.*

[6] A. W. Fahrenwald, *et al.; op. cit.*

Table II—Series I. Lead Ore. Using 500-Gram Machine

Test No.	Calculated Head Assay Pb, %	Calculated Head Assay Ag, Oz/Ton	% Solids in Pulp	Concentrate Wt., Grams	Concentrate Pb, %	Concentrate Ag, Oz/Ton	Tailing Wt., Grams	Tailing Pb, %	Tailing Ag, Oz/Ton	Ratio of Conc.	Recovery % Pb	Recovery % Ag
1	9.48	3.55	5	28.0	37.4	14.6	96.5	1.4	0.35	4.44	88.6	92.4
2	9.38	3.63	10	51.5	41.8	16.6	207.0	1.3	0.40	5.03	88.8	91.1
3	9.09	3.56	15	74.0	43.7	17.6	329.0	1.3	0.40	5.45	88.2	90.8
4	9.28	3.63	20	117.0	39.9	15.9	443.0	1.2	0.40	4.78	89.7	91.2
5	9.46	3.55	25	122.0	47.0	18.5	590.0	1.6	0.55	5.98	85.9	87.1
6	9.01	3.54	30	162.5	43.3	17.2	662.0	1.6	0.60	5.64	85.4	86.1
7	8.95	3.56	35	208.0	40.8	16.3	913.0	1.7	0.65	5.38	84.5	84.8
8	8.92	3.56	40	224.0	40.5	16.4	1,120.5	2.6	1.00	6.02	75.6	76.6

pH of tailing 7.8 to 8.1 in all tests

(Table VI-A) is the same as test No. 68 except that the amount of $CuSO_4.5H_2O$ has been reduced to 0.214 lb. per ton of ore. This corresponds to the same amount of $CuSO_4.5H_2O$ that would give 0.50 lb. per ton in a 25 per cent solids pulp (test No. 65). Here the recovery drops to 78.4 per cent, compared with 99.4 per cent in test No. 68.

In connection with the question of the effect of time of frothing on recovery, it is interesting to note that at the end of 18 minutes of frothing the recovery from a 40 per cent solids pulp is almost as great as that from a 5 per cent solids pulp (tests 61 and 68). At the end of 6 minutes (first froth) the recovery is actually 4.4 per cent greater in the case of the pulp containing 40 per cent solids.

Flotation of Copper Ore—The reagents used in the flotation of the copper ore were as follows: CaO, 5.7 lb. per ton of ore; sodium ethyl xanthate (Great Western Z-4), 0.10 lb. per ton of ore; and pine oil, 4 drops (0.03 gram) per test. The pulp was first agitated with the CaO for a 20-minute period, then the xanthate was added and agitation continued for 3 minutes longer, then the pine oil was added and the air turned on for the final 3-minute conditioning period. Three 6-minute froths and a fourth froth were collected as in the case of the zinc ore. Table VII gives the data obtained from tests in Series VI.

Recovery of copper in the tests of Series VI is nearly constant at all pulp densities; there is only a slight drop at 40 per cent solids. The function of CaO is primarily to depress the iron, and evidently the concentration of CaO in the water is an important factor, because the grade of the concentrate and the ratio of concentration both increase as the pulp density increases, although the amount of CaO in pounds per ton of ore is the same in all cases. Note also the gradual increase in the pH of the tailing water. It was thought that CaO in high concentrations might depress the copper minerals, and that the slight drop in recovery in tests Nos. 86-88 might be due to the high concentration of lime. To test this surmise, the tests given in Table VIII were made. These were identical with the tests in Series VI except that a constant amount of CaO (1.581 grams) was used in each test. Only two froths were taken, the first for 6 minutes and the second for the rest of the time required.

In Series VII we find that the recovery and ratio of concentration are remarkably constant in the last four tests. Recovery is somewhat lower in test No. 92 than in test No. 82, and this may be due to the larger amount of CaO per ton of ore in test No. 92.

The tests on the copper and zinc ores apparently show that pulp density has no effect on flotation recovery except for the incidental effect caused by the change in concentration of the reagents in the pulp. The tests on the lead ore and the previous tests on four gold ores[7], however, show quite definitely that flotation recovery decreases at higher pulp densities. Inasmuch as the gold ores and the lead ores all contained primary

[7] A. W. Fahrenwald, *et al., op. cit.*

Table III—Series II. Lead Ore. Using 500-Gram Machine

Test No.	Calc. Head Assay, % Pb	% Solids in Pulp	First Conc. Grams	First Conc. % Pb	Second Conc. Grams	Second Conc. % Pb	Third Conc. Grams	Third Conc. % Pb	Tailing Grams	Tailing % Pb	Ratio of Conc. (Total)	Recovery, % 1st Conc.	2d Conc.	3d Conc.	Total
11 (*a*)	7.53	5	74.4	34.1	12.8	3.5	13.8	2.5	272	0.8	3.68	89.6	1.6	1.2	92.4
12 (*b*)	7.54	10	103.4	34.1	18.3	3.3	17.5	2.3	378	0.7	3.75	90.6	1.6	1.0	93.2
13	8.98	15	82.9	39.5	9.2	6.7	6.7	4.0	305	0.9	4.10	90.3	1.7	0.7	92.7
14	8.96	20	128.2	35.5	12.0	5.2	10.0	3.3	410	0.9	3.73	90.8	1.3	0.55	92.6
15	8.86	25	157.0	36.2	12.5	6.1	11.1	4.3	550	1.2	4.05	87.9	1.2	0.7	89.8
16	9.23	30	187.5	39.5	30.5	5.6	17.3	3.3	682	1.2	3.93	87.7	2.0	0.6	90.3
17	8.62	35	217.5	37.2	29.6	6.6	16.0	4.7	857	1.5	4.25	83.8	2.0	0.8	86.6
18	8.95	40	222.1	41.8	38.3	10.0	30.5	5.6	1,054	2.1	4.64	77.0	3.2	1.4	81.6

(*a*) Composite of three identical tests. (*b*) Composite of two identical tests. pH of tailing 7.8 to 8.1 in all tests

Table IV—Series III. Lead Ore. Using 500-Gram Machine

Test No.	Calc. Head Assay, % Pb	% Solids in Pulp	First Conc. Grams	First Conc. % Pb	Second Conc. Grams	Second Conc. % Pb	Third Conc. Grams	Third Conc. % Pb	Tailing Grams	Tailing % Pb	Total Time of Frothing, Minutes	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	3d Conc.	Total
11 (*a*)	7.53	5	74.4	34.1	....	....	....	....	272	0.8	6.0	5.04	89.6	....	....	89.6
12 (*b*)	7.54	10	103.4	34.1	18.3	3.3	....	....	378	0.7	12.5	4.25	90.6	1.6	....	92.2
13	8.98	15	82.9	39.5	9.2	6.7	6.7	4.0	305	0.9	19.5	4.10	90.3	1.7	0.7	92.7
24	7.34	20	99.3	37.4	16.5	4.9	22.4	2.9	422	0.6	27.0	4.06	90.2	2.0	1.6	93.8
25	7.61	25	150.1	32.6	20.1	5.6	28.2	2.9	532	0.9	35.2	3.68	87.9	2.0	1.3	91.2
28	7.67	40	204.3	38.7	30.6	8.1	100.4	3.6	1,009	1.77	64.7	4.02	76.8	2.4	3.5	82.7

(*a*) Composite of three identical tests. (*b*) Composite of two identical tests. pH of tailing 7.8 to 8.1 in all tests

Table V—Series IV. Lead Ore. Using 500-Gram Machine. Amount of Xanthate Constant

Test No.	Calc. Head Assay, % Pb	% Solids in Pulp	First Conc. Grams	First Conc. % Pb	Second Conc. Grams	Second Conc. % Pb	Third Conc. Grams	Third Conc. % Pb	Tailing Grams	Tailing % Pb	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	3d Conc.	Total
21A (*a*)	7.63	5	84.7	31.0	9.9	3.3	10.1	2.5	269.0	0.6	3.55	92.2	1.3	0.9	94.4
22A (*b*)	7.78	10	118.7	31.6	14.1	3.3	11.5	2.1	372.3	0.5	3.57	93.5	1.3	0.6	95.4
23A	7.58	15	88.3	31.8	9.8	4.6	9.7	2.3	295.7	0.6	3.74	92.0	1.5	0.7	94.2
24A	7.61	20	111.5	34.5	12.5	4.2	8.6	2.7	428.6	0.8	4.27	90.3	1.2	0.5	92.0

(*a*) Composite of three identical tests. (*b*) Composite of two identical tests. pH of tailing 7.8 to 8.0 in all tests

Table VI—Series V. Zinc Ore. Using 500-Gram Machine

Test No.	Calc. Head Assay, % Zn	% Solids in Pulp	First Conc. Grams	First Conc. % Zn	Second Conc. Grams	Second Conc. % Zn	Third Conc. Grams	Third Conc. % Zn	Fourth Conc. Grams	Fourth Conc. % Zn	Tailing Grams	Tailing % Zn	Total Time of Frothing Required, Minutes	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	3d Conc.	4th Conc.	Total
61 (*a*)	7.70	5	39.0	45.5	9.4	10.4	7.1	3.9	....	....	205.5	0.05	6.0	6.36	93.0	5.1	1.5	...	99.6
62	7.47	10	41.2	43.7	7.1	6.5	7.5	2.2	....	....	200.0	0.20	12.4	5.30	94.6	2.4	0.9	...	97.9
63	7.49	15	67.2	43.7	14.2	2.4	9.6	0.5	....	....	307.0	0.05	19.3	4.38	97.6	1.8	0.15	...	99.5
64	7.96	20	88.1	45.6	10.2	6.1	13.0	2.8	8.9	1.2	430.0	0.60	26.5	4.55	91.7	1.4	0.8	0.20	94.1
65	8.28	25	87.0	49.5	10.1	17.2	8.6	9.4	21.3	13.8	588.0	1.8	34.5	5.63	72.9	2.9	1.4	5.0	82.2
66	8.32	30	127.8	50.4	12.6	7.7	12.5	7.2	44.7	2.9	694.0	1.0	43.2	4.52	86.8	1.3	1.2	1.7	91.0
67	8.02	35	175.7	46.6	27.1	9.5	26.0	2.9	36.6	3.4	819.0	0.06	52.5	4.09	94.1	3.0	0.9	1.4	99.4
68	8.06	40	218.8	46.3	24.0	4.9	36.6	2.3	50.4	0.4	962.0	0.06	62.5	3.93	97.4	1.0	0.8	0.1	99.4

(*a*) Composite of two identical tests. pH of tailing 8.0 to 8.2 in all tests

Table VI-A—$CuSO_4.5H_2O$ = 0.214 Lb./Ton of Ore

69	8.20	40	174.3	43.0	15.5	9.2	12.1	5.5	48.0	14.6	1042.4	2.1	62.5	5.15	69.9	1.3	0.6	6.6	78.4

slimes, and since the copper and zinc ores were free of slime, it was thought that possibly the slimes might be responsible for the decreased recoveries at high pulp densities. To test this hypothesis, the tests in Series VIII were made on a sample of one of the gold ores (ore No. 4) used in the previous investigations.[8]

Flotation of Gold Ore—The gold ore used was an oxidized gold ore from Nelson, Nev., and contained about 0.85 oz. of gold per ton, with only small amounts of sulphides. The sample available had been crushed to pass a 6-mesh screen. A portion of this 6-mesh material was deslimed by repeated decantation, and the deslimed ore was then dry-ground and floated. Another portion of the ore was simply wetted and dried (to duplicate as far as possible the treatment given the deslimed portion), dry-ground and floated. The reagents used were as follows: Na_2CO_3, 0.25 gram per test; pine oil, 6 drops (0.045 gram) in tests at 20, 30, and 40 per cent solids; 4 drops (0.030 gram) in tests at 5 and 10 per cent solids; and pentasol xanthate, 0.05 lb. per ton of ore.

The flotation schedule was: (1) conditioning for 3 minutes with Na_2CO_3 and xanthate (without air); (2) conditioning for 3 minutes with pine oil (with air); and (3) froth removed in two stages; first, for 15 minutes, second, for time required. The only exceptions are in tests 101 and 111, where two 15-minute froths were taken, although the time actually required was only 7.3 minutes.

Apparently there is only a slight decrease in recovery at high pulp densities on the deslimed ore, but there is a pronounced decrease in the recovery at high pulp density for the natural ore, as was found in the previous investigation. The grade of concentrate and ratio of concentration are also much lower in the case of the natural ore.

It is difficult to draw any definite conclusions about the effect of pulp densities on flotation recovery, ratio of concentration, etc., because of the other variables which change as the pulp dilution changes. For instance, in comparing the floatability of a zinc ore in pulp densities of 10 and 40 per cent solids there is no way to tell that we have all other variables "constant" so that the pulp density alone is causing the effects noted. Suppose we keep the amount of copper sulphate per ton of ore constant. Then we have a copper sulphate solution in the denser pulp, which is several times as concentrated as the liquid in the more dilute pulp, and this will have a pronounced effect on floatability. If, on the other hand, we keep the concentration of copper sulphate in the water constant, we have much less of the reagent on a pounds-per-ton-of-ore basis in the denser pulps. This concerns only one reagent—probably the Na_2CO_3, and xanthate concentrations have similar effects; also the correct frothing time should be determined.

Tentative conclusions drawn from the work done to date on flotation pulps varying in density from 5 per cent to 40 per cent solids are as follows:

1. Pulp density in itself has little or no effect on recovery, speed of flotation, ratio of concentration, or grade of concentrate. Many secondary changes which necessarily accompany changes in pulp dilution may have pronounced effects on flotation.

2. High pulp densities appear to aggravate the harmful effects of slimes.

3. Where there is nothing to impede the flotation of a mineral, the frothing time required seems to be independent of the pulp density. In other words, if a 98 per cent recovery can be made in 10 minutes from a pulp containing 10 per cent solids, it is probable that the same recovery could be made from a 40 per cent pulp (containing almost five times as

(*Continued on page* 48)

[8] A. W. Fahrenwald, *et al.; Ibid.*

Table VII—Series VI. Copper Ore. Using 500-Gram Machine

Test No.	Calc. Head Assay, % Cu	% Solids in Pulp	First Conc. Grams	First Conc. % Cu	Second Conc. Grams	Second Conc. % Cu	Third Conc. Grams	Third Conc. % Cu	Fourth Conc. Grams	Fourth Conc. % Cu	Tailing Grams	Tailing % Cu	Total Time Frothing Required, Minutes	pH	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	3d Conc.	4th Conc.	Total
81 (a)	6.00	5	104.1	12.6	13.0	7.85	6.1	6.47	....	....	125.0	0.28	6.0	11.3	2.39	88.0	6.9	2.7	....	97.6
82	6.27	10	121.5	12.75	3.7	4.9	2.7	3.00	....	....	129.0	0.28	12.5	11.5	2.06	95.1	1.1	0.5	....	97.7
83	6.09	15	174.5	13.4	10.9	3.05	4.8	2.31	....	....	210.0	0.23	19.2	11.8	2.11	96.1	1.4	0.5	....	98.0
84	5.92	20	246.3	12.85	8.2	2.85	5.9	1.90	7.6	1.15	287.0	0.23	26.7	12.1	2.07	96.7	0.7	0.35	0.25	98.0
85	6.08	25	226.2	18.5	12.7	3.14	6.3	2.59	4.0	1.76	472.0	0.28	34.9	12.1	2.90	94.55	0.9	0.4	0.15	97.0
86	6.27	30	248.9	21.5	9.1	4.62	5.2	2.22	6.9	2.22	632.0	0.37	43.9	12.1	3.35	94.65	0.75	0.2	0.3	95.9
87	6.16	35	282.0	22.7	16.6	5.08	8.1	2.50	15.2	1.39	777.0	0.32	53.1	12.2	3.41	94.4	1.30	0.3	0.3	96.3
88	6.04	40	261.4	28.0	18.7	4.90	6.5	2.22	18.3	1.11	1,009.0	0.46	63.5	12.3	4.30	92.55	1.15	0.2	0.25	94.15

(a) Composite of two identical tests.

Table VIII—Series VII. Copper Ores. Using 500-Gram Machine

Test No.	Calc. Head Assay % Cu	% Solids in Pulp	First Conc. Grams	First Conc. % Cu	Second Conc. Grams	Second Conc. % Cu	Tailing Grams	Tailing % Cu	Total Time of Frothing Required, Minutes	pH	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	Total
92 (a).....	6.17	10	81.1	18.2	....	....	176.0	0.62	12.5	12.2	3.37	93.7	....	93.7
84.....	5.92	20	246.3	12.85	21.7	2.0	287.0	0.23	26.7	12.1	2.07	96.7	1.3	98.0
95.....	6.26	25	261.1	16.6	29.8	3.6	430.0	0.21	34.9	12.1	2.48	95.6	2.4	98.0
96.....	6.25	30	332.2	16.4	33.3	1.75	536.0	0.23	43.9	11.5	2.47	96.8	1.0	97.8
97.....	6.16	35	384.3	17.0	39.7	1.94	675.0	0.23	53.1	11.3	2.59	96.8	1.1	97.7

(a) One froth only, taken for 12.5 minutes. (1.581 grams CaO per test)

Table IX—Series VIII. Gold Ore—Deslimed Sands—89.6% by Weight of Original Sample. Using 500-Gram Machine

Test No.	Calc. Head Assay, Au Oz/T	% Solids in Pulp	First Conc. Grams	First Conc. Oz Au/Ton	Second Conc. Grams	Second Conc. Oz Au/Ton	Tailing Grams	Tailing Oz Au/Ton	Total Time of Frothing Required, Minutes	pH	Ratio of Conc. (Total)	Recovery % 1st Conc.	2d Conc.	Total
101.....	0.767	5	4.06	20.42	4.01	0.73	115.7	0.08	7.3	8.0	15.3	87.2	3.1	90.3
102.....	0.779	10	11.14	16.10	.....	.....	244.5	0.08	15.0	8.0	22.8	89.6	...	89.6
104.....	0.725	20	20.67	17.28	14.25	0.56	511.8	0.06	32.2	8.0	26.4	90.1	2.1	92.2
106.....	0.762	30	26.13	21.25	30.44	0.94	824.4	0.05	51.7	8.1	33.7	88.8	4.5	93.3
108.....	0.763	40	42.53	19.65	71.50	0.54	1,154.4	0.08	74.6	8.0	29.8	86.4	4.0	90.4

Table IX-A—Gold Ore as Received, Containing Slimes

111.....	0.819	5	4.66	18.80	2.05	1.01	117.1	0.10	7.3	8.1	18.6	86.45	2.35	88.8
112.....	0.850	10	12.22	13.78	....	....	243.4	0.20	15.0	8.1	20.9	77.60	....	77.6
114.....	0.905	20	31.20	11.28	16.55	0.49	498.9	0.27	32.2	8.2	11.7	72.70	1.6	74.3
116.....	0.990	30	60.82	9.42	43.90	0.43	775.3	0.36	51.7	8.2	8.42	65.90	2.2	68.1
118.....	0.912	40	82.17	9.04	81.10	0.47	1,106.1	0.34	74.6	8.1	7.76	64.30	3.3	67.6
122 (a).....	0.640	10	23.80	3.62	....	....	100.0	0.34	15.0	8.0	11.7	52.7	....	52.7

(a) Test made on dried slimes.—Procedure and reagents as in test No. 112.

New Jersey's Iron Ore Production

Over half a million tons of magnetite was produced in 1937—Fully equipped properties in the State now number five

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IRON ORES have been mined in New Jersey for more than two centuries. Although bog ore, limonite, and red hematite had been produced in sizable quantities early in the State's history, the bulk of the tonnage has been and is now virtually all magnetite. This ore was first mined there in 1710, and production has since been continuous.

Peak production of iron ore in New Jersey was reached in 1882, when 932,762 long tons were shipped. In that year the State ranked second in production of iron ore, being exceeded only by Michigan. At this time the ores were used for making pig iron in New Jersey and also found a ready market in New York and eastern Pennsylvania. After 1882 production in New Jersey declined, because of the entry of Lake Superior iron ores into the market and later because of the use of foreign ores at Eastern seaboard furnaces. Annual output and value per long ton are shown in Table I and the accompanying graph beginning with 1894, the first year for which a breakdown is shown by the Bureau of Mines.

During the first decade of the twentieth century production in New Jersey was at a high rate, averaging over 480,000 tons per year, but declined substantially in the pre-War years and recovered during some of the War years. It again declined in the post-War slump, but recovered moderately from 1924 to 1930, to fall again during the depression. In general, and until recently, the trend has been downward during the last quarter century, whereas for the United States as a whole it has been upward.

Several factors have contributed to this reverse trend. Principally they appear to be the use of Lake ore at Eastern furnaces and the use of foreign ore at seaboard plants, particularly since the War. Furthermore, 25 years ago the principal markets for Jersey ores were eastern Pennsylvania, New Jersey, and New York. Since 1920 a large number of merchant pig-iron furnaces in this area have been scrapped and their market in large part has been permanently lost. For example, in 1920 there were 71 stacks with an annual capacity of 5,338,100 tons in eastern Pennsylvania and New Jersey, whereas in 1935 there were only 15 furnaces in eastern Pennsylvania, with a capacity of 2,750,080 tons, and none in New Jersey. Thus nearly all merchant pig-iron furnaces in this area have ceased operation, leaving a limited market for New Jersey ores, while surplus domestic cold pig iron from steel-plant furnaces and imported pig iron are being used.

Active post-depression demand, however, stimulated demand for New Jersey ores, so that production in 1936 was over 190,000 long tons. In 1937 this rose to 549,600 tons. Several factors helped. From a technological standpoint they are:

1. Adoption of mining methods yielding greater output per man-hour.

2. Improved milling equipment and processes which produce a higher-grade product and yield a better recovery at a reasonable cost.

3. In some properties, at least, the classification and preparation of gangue material for sale as a valuable byproduct credit.

From an economic viewpoint the following factors have been advanced as contributing to the reopening of the mines after the depression:

1. Blast-furnace operators have found that, other conditions being equal, sintered ores will give better results and larger daily tonnage than raw ores.

2. Other conditions being equal, it is more economical to sinter magnetic iron ore than hematite, because the former contains less fines and can therefore be sintered more rapidly than the latter. With proper physical preparation, the Eastern magnetites will reduce as easily as Lake hematites. Moreover, inasmuch as magnetite has a higher content of iron than hematite ores, any given tonnage of the former will yield a greater tonnage of iron than if hematite were used.

3. Freight rates from New Jersey mines to Eastern furnaces are slightly less than those from competing mines in New York and other states.

More recently the large export of ferrous scrap, with attendant high prices, undoubtedly has increased the domestic demand for pig iron, and at the same time there has been a large increase in pig-iron exports and even inquiries for the export of iron ore.

Still another factor influencing production at some of the mines where the raw ore is of high grade is the recovery of lump magnetite by hand-sorting for use in the open-hearth furnace. This material brings a good price and is shipped as far west as Pittsburgh. In June, 1937, the producers were getting $5.50 per ton at the mines for open-hearth lump. At the Mount Hope mine this is an important factor.

Table I—Production of Magnetite in New Jersey, 1894-1936 Inclusive

Year	Production, Gross Tons	Average Value per Ton	Year	Production, Gross Tons	Average Value per Ton
1894	277,483	$2.05	1916	528,084	$3.55
1895	282,433	2.17	1917	474,708	4.93
1896	264,999	2.00	1918	375,238	5.19
1897	254,235	1.93	1919	334,434	5.08
1898	275,438	2.37	1920	411,702	6.24
1899	256,185	3.18	1921	111,260	4.75
1900	334,247	2.78	1922	90,374	4.43
1901	401,989	2.28	1923	398,894	4.31
1902	441,879	2.78	1924	100,167	4.15
1903	484,796	2.74	1925	163,593	4.11
1904	499,949	2.25	1926	209,687	4.33
1905	526,271	2.41	1927	201,382	4.23
1906	521,907	2.91	1928	384,621	3.87
1907	502,942	3.38	1929	284,099	4.05
1908	389,616	2.94	1930	390,999	4.17
1909	539,225	2.96	1931	239,722	4.10
1910	517,919	3.03	1932	14,966	3.54
1911	357,623	3.22	1933	73,385	3.32
1912	366,823	3.25	1934	145,326	3.81
1913	291,653	3.36	1935	80,302	4.29
1914	346,820	3.10	1936	192,935	4.73
1915	391,115	2.92	1937	(a)549,600	(b)5.50

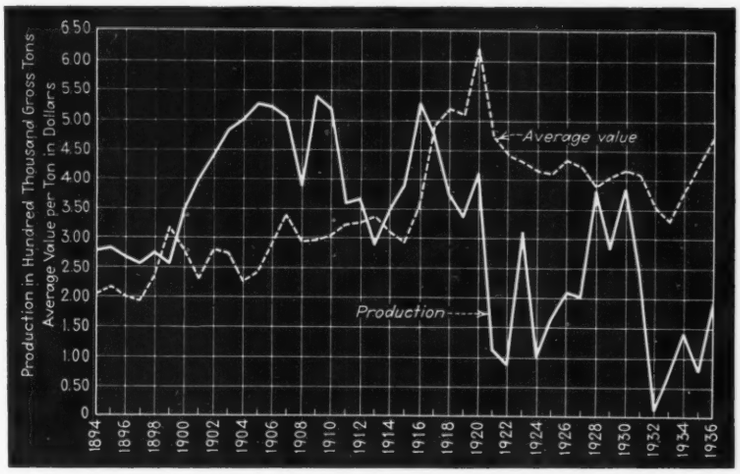
(a) Mining and Metallurgy, Jan., 1938. (b) Estimated.

Table II—Estimates of Iron-Ore Reserves in New Jersey

Long Tons of Ore	Per Cent Iron	Year of Estimate	Authority
160,000,000[d]	52	1908	Hayes
135,000,000	52	1909	Butler-Birkinbine
366,000,000	30	1916	Le Fevre
604,000,000	40–60	1937	Roche

[d] Includes New York.

Displays Upward Trend



PRODUCTION of magnetite in New Jersey and the average value per ton are shown for the years 1894 to 1936 inclusive

At present there are five fully equipped mines in New Jersey. These are the Mount Hope, at Wharton; the Richard, also at Wharton; the Ringwood, at Ringwood; the Scrub Oak, at Dover; and the Washington, at Oxford.

Each of these mines is equipped with a magnetic separation plant. At some of the plants concentration is wet, at others dry, and at others both wet and dry. At two of the mills, at least, wet gravity methods are used to recover the non-magnetic martite.

The following observation made recently by H. M. Roche is significant:

"In the past, New Jersey iron mines have not received the attention they deserved because of their tie-up with Eastern merchant furnaces. Mines owned by merchant furnaces were operated intermittently and production was held to requirements of one or two small furnaces. No attempt was made to work mines at a production rate in proportion to the size of the orebodies. As a consequence, costs were high, the orebodies were considered to be small and not capable of sustaining large production. For instance, shipments from one mine in the Dover district for many years averaged 100,000 tons, although the orebodies were large enough for a continuous output of 500,000 tons, and the magnetic concentrating mill had a capacity of 400,000 tons annually. If this mine had been operated at maximum output, operating costs would have been reduced $1 per ton and it would have been ranked as one of the 25 largest iron mines in the United States. The neck of the bottle in New Jersey iron-ore mining has been ownership and operation by small merchant furnaces."

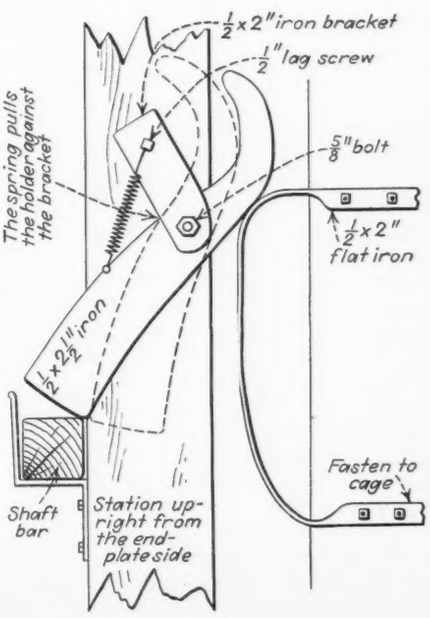
The Geological Survey of New Jersey reports 366 deposits of magnetite in that State that have been mined at one time or other. Although some of the deposits are small, the reserves of magnetite in New Jersey are large. Estimates of various authorities are given in Table II. In 1914, E. C. Eckel in discussing the Hayes report wrote:

"A more promising field lies in the older Eastern states. It is probable that careful exploratory work will develop magnetic iron ores in New York, New Jersey, and Pennsylvania in quantities far in excess of anything usually considered possible in those states. We have really little reliable information concerning the important magnetite deposits of the highlands of New York and New Jersey, and under these circumstances the Hayes estimate may be accepted tentatively as the best available at the moment."

Safety Device for Mine Shaft

AT LEVEL STATIONS in mine shafts, the miners, while waiting for the cage, sometimes raise the safety bar to save time, according to Charles Labbe, Goldfield, Nev. In practice this has not proved a time saver, but a dangerous habit, as the risks due to human failing have caused fatal accidents.

To meet this situation, a simple device of two pieces, a cam and a bar holder, has been designed to keep the bar in place until the cage has arrived at the proper place. The cam consists of a piece of flat iron bent to shape and fastened to the cage, not on the wall-plate side, as there is not enough clearance, but between the guide and the corner of the cage (spreader or end-plate side). The holder is a rough forging or a piece of heavy plate cut to shape to meet the purpose. In such a place, and for such work, the piece must be as simple as possible and automatic in action,


½ x 2" iron bracket
½" lag screw
⅝" bolt
½ x 2" flat iron
The spring pulls the holder against the bracket
½ x 2½" iron
Fasten to cage
Shaft bar
Station upright from the end-plate side

and, in general, so designed as to require only a minimum amount of attention.

This holder swings on a bolt in a bracket fastened to the station timber, the upper end being the friction part acted on by the cam on the cage. So that it cannot be worked by hand, a stiff enough coil spring is hooked onto the side, or a flat one on the back side; the frame work of the station suggests the kind of spring needed.

The sketch shows the shape of the bar holder permitting the bar to be let down any time, and which can be raised only when the cage moves into the right position to discharge passengers or unload or load supplies. Simplicity in design has to be kept in mind as the main requisite for safety and operation. The device described in the foregoing has proved itself entirely satisfactory in obviating the risks noted.

Sink-and-Float Separation

(*Continued from page 39*)

parting liquid loss experienced in the operation of the plant described in the foregoing, however, was for rice coal, which showed a loss of 12.4 oz. per ton of cleaned coal.

Results obtained through the operation of the plant at Shenandoah were very satisfactory. Approximately 20,000 tons of material was passed through the plant. From this material, 14,754.91 tons of cleaned coal was produced. The equipment operated 722 hr. and 3 min., and coal was fed to the plant 654 hr. and 34 min. In all, 295 50-ton railroad gondolas were loaded with products of the plant. Of these only 19¾ cars were condemned and for the reasons given in Table II, which appears on page 43.

Of the 295 cars of coal prepared, it is interesting to note that only 5 were condemned for material which should have been extracted by the process, and of these, those of 8/29/36 and 9/1/36 were separated on parting liquid having a gravity too high due to the effect of the water film placed on the material by the active agent. This material should not have been put through the plant without changing the gravity of the parting liquid left in the separator from the previous run. The two cars of 7/24/36 and one car of 10/24/36 were condemned during runs made to determine the capacity of the separator, the feed being increased until a product was produced which would not pass the specification that is required for the finished product.

A test was run on the mixed refuse as produced by one of the most satisfactory methods now in use in the anthracite industry. This refuse, in addition to the original preparation, had been recleaned in a rock jig. The results shown in the chart in Fig. 5 may be considered as indicative of the operation from the ore-dressing standpoint, as the heavy refuse can be considered the desired concentrate and the recovered coal will represent the gangue.

Estimated cost of constructing and operating commercial installations, based on data obtained through the operation of the plant described, shows a material reduction in over-all cost when compared with other current practice.

The range of sizes which can be handled in one separation depends on two factors: the quality of concentrate desired, and the shape of the particle being handled. It has been shown in the general description that thorough scrubbing of all particles was necessary to remove the parting liquid and silt after separation. It can be seen that the liquid loss would be excessive in the event 4-in. flats were separated with ½-in. round particles, as a large flat could easily cover a ½-in. particle. Satisfactory washing is obtained with a size ratio of 4:1 provided a large number of flat pieces of the upper size exist in the material being handled in the plant.

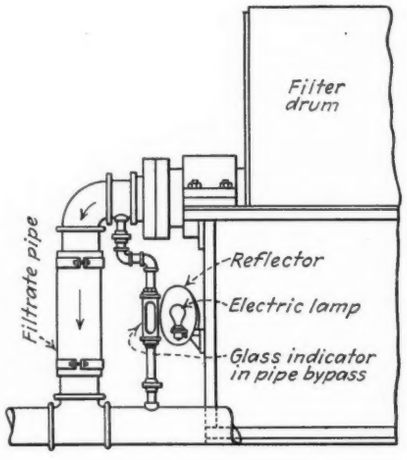
There are, however, certain practical limitations to the commercial process. It seems that the machinery required to handle material in sizes larger than those which will pass a 6-in. round opening would be so large that it would be uneconomical. There is nothing, however, to prohibit the treatment of material in sizes larger than 6 in. if there is any real advantage in so doing.

Possibilities and limitations of the sink-and-float process described must be carefully considered when contemplating its use in commercial application. In brief, the process is applicable to coal and to all minerals—metallic or non-metallic—which can be freed from their gangue or from each other in sizes plus eight mesh, Tyler standard screen scale. It may be used on run-of-mine feed or for recovering the values in the tailings or refuse delivered from existing plants. In addition, it may be used as a preliminary concentrator or rougher-out ahead of other processes.

Due to the fact that the specific gravity or density of the parting liquid remains constant in operation and that its viscosity is the equivalent of that of water, it is possible to sort materials having exceedingly close specific gravities; for example, quartz, specific gravity 2.66, from calcite, specific gravity 2.71. An operation of this kind requires very close sizing due to the effect of the water film on the apparent density of the particles.

▼ ▼ ▼

Checking Filter Operation



MAXIMUM filter performance depends principally on the quality and condition of the cloth covering the drum or disks of a continuous-vacuum filter. A defective covering means reduced over-all efficiency and a "cloudy" filtrate (one which contains a large amount of solids) that causes rapid wear of auxiliary filter units such as pumps, valves, and others. Though replacement of a worn or perforated cloth is a relatively easy matter, its detection may require some time, especially if the filter installation does not contain an indicator to observe the filtrate drawn from the submerged portion of the filter drum or disk.

At the Consolidated Mining & Smelting Company's concentrator at Chapman Camp, B. C., the problem was solved by the arrangement explained in the sketch. Here, constant observation of the filtrate is permitted by a pipe bypass with a glass indicator installed between the short pipe nipple extending from the hollow drum shaft and the pipe leading to the filtrate pump. Increased visibility is provided by an electric light and deflector secured to the end wall of the filter basin a short distance from the indicator. All parts used in the set-up were made from scrap. The condition of the cloth is constantly indicated by the color of the filtrate. Operations are normal when it is clear. When it is cloudy the cloth is defective.

Pulp Density

(*Continued from page 45*)

much ore per unit volume) in practically the same time.

4. The effect of inorganic flotation reagents appears to depend upon the concentration of the reagent referred to the water of the pulp, as well as to the conventional pounds-per-ton-of-ore concentration. In many cases, the first may be the more important.

5. Higher pulp densities might give more economical operation by (1) increasing the capacity of flotation machines, and (2) decreasing the amount of reagent required on a pound-per-ton-of-ore basis.

The Sullivan Mill Revisited

At Kimberley, B. C., the Consolidated Mining and Smelting Company of Canada is treating 6500 tons of lead-zinc ore daily by flotation

John B. Huttl
Assistant Editor

▶ UNDERGROUND OPERATIONS *at the great Sullivan mine of the Consolidated Mining and Smelting Company of Canada were described by the author in the April issue, following a recent visit to the property. The present article gives an up-to-date picture of the selective flotation of the heavy sulphide ore in the concentrator.*

ORE RECEIVED from the Sullivan mine, at Kimberley, B. C., at the coarse-crushing plant near the portal of the 3,900 level tunnel, is fairly uniform in grade and averages 10 per cent lead and 7 per cent zinc. Save for discontinuance of hand-sorting, no material changes from the practice previously described have been made in crushing. Ore drawn from a 1,200-ton receiving bin is successively treated in two jaw crushers, a 36x48-in. Allis-Chalmers and a 36x42-in. Buchanan, and in three Traylor No. 10 gyratory crushers, the crushed product being delivered to a shuttle conveyor on top of a 2,800-ton storage bin. Here it is loaded into air-dump cars and hauled in trains to the 1,800-ton reinforced-concrete receiving bin at the concentrator about 2 miles distant.

The concentrator is now handling 6,500 tons of ore a day, and the diverse treatment the 4-in. product from the coarse-crushing plant undergoes there is explained in the accompanying flowsheet. At the fine-crushing plant, ore drawn from the 1,800-ton receiving bin is conveyed direct to a 7-ft. Symons cone crusher which is in open circuit and discharges a ¾-in. product into a steel surge bin. This is then passed over four 4x5-ft. Hum-mer screens covered with Ty-rod screens containing 4¾x¼-in. openings. The screen undersize is conveyed direct to the fine-ore storage plant, consisting of a catenary steel bin of 5,000 tons' capacity and a 3,700-ton concrete bin. Oversize is retreated in two sets of Allis-Chalmers 74x20-in. Garfield-type rolls operating in closed circuit with the Hum-mers. The final screen product delivered to the storage plant is 17 per cent plus 4 mesh and 67 per cent minus 6 mesh.

Both storage bins are served by Link-Belt bedding machines, and withdrawal of ore is effected by both apron and drum-type feeders. Six Merrick Weightometers control the feed to the primary ball mills. As the heavy sulphide ore (7 cu.ft. to the ton) oxidizes rapidly, and satisfactory recovery by flotation depends on treating comparatively fresh ore, great care is exercised in bedding and drawing operations at the fine-ore bins and the intermediate receiving and storage bins, as well as in drawing from the stopes. All sampling is done automatically.

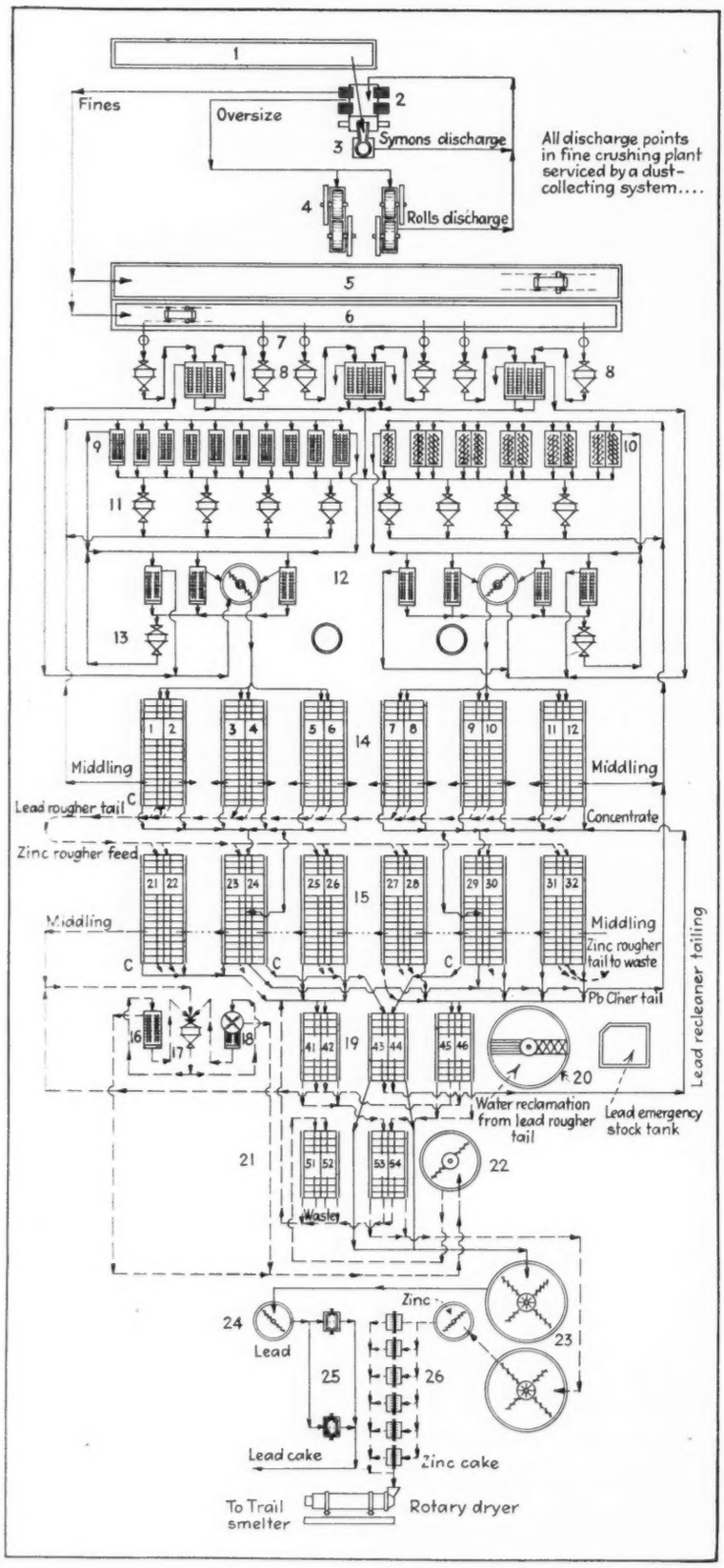
Complete dust-recovery systems are installed at the coarse- and fine-crushing plants. All are alike in design, but differ in size and capacity. The scheme of operation is relatively simple. Crushing and screening equipment and the head and tail end of conveyors are provided with dust-tight hoods connected to a flue system made from 8-in. or 12-in. sheet-metal pipes leading into headers of larger diameters (35 in. at the fine-crushing plant, and 30 in. and 18 in. respectively at the coarse-crushing plant). These in turn discharge into conical cyclone separators, where the coarse particles are dropped, while the air laden with fine dust is drawn into a spray tank. This unit is composed of an inner and an outer compartment, between which are two concentric baffles. As the air passes under and over these baffles, it is filtered through twelve tiers of water sprays, with the dust being drawn off at the bottom of the tank as a sludge.

The slow-speed exhaust fan operating the collector at the fine-crushing plant discharges 13,250 cu.ft. of air per minute under normal conditions at 4-in. water gage, and at the coarse-crushing plant a similar unit discharges 20,000 cu.ft. at 5½-in. water gage. Both are Sturtevant No. 80 exhaust fans. The main header of the second dust collector at the coarse-crushing plant, only 18 in. in diameter, discharges into two No. 20 Sirocco Type D collectors operated in parallel, with no spray tank. The No. 45 E. L. Sirocco fan used discharges 6,400 cu.ft. of air per minute at 4-in. water gage.

Dust recovered at the fine-crushing plant amounts to about 200 lb. per hour, or 3,600 lb. per operating day of 18 hr. The material, of which 98.2 per cent will pass a 325-mesh screen, is of slightly higher grade than the mill feed. All plants are constructed after the designs of George E. Lynch, of Los Angeles.

As pointed out previously, the ore of the Sullivan mine is a variable mixture of lead, zinc, and iron sulphides with relatively small amounts of gangue, mainly calcite and quartz. To liberate the individual mineral particles, fine grinding is essential. This is done in three stages. On the primary grinding floor, where experiments with closed-circuit grinding are in progress at present, there are six 10-ft. by 48-in. Hardinge ball mills, each fitted with rubber-covered trommel screens with inner spiral to remove chips, which discharge to three 16x20-ft. Dorr quadruplex classifiers. The overflow, a 90 per cent minus-20-mesh product, goes to two flotation surge tanks (30 ft. and 20 ft. in diameter), and the sands are reground in four 8-ft. by 48-in. and four 10-ft. by 48-in. secondary Hardinge ball mills operating in closed circuit with ten 6x25-ft. Dorr duplex and eleven 6-ft. Akins spiral classifiers. Secondary classifier overflow (85 per cent minus 200 mesh) is pumped to distributors feeding seven 6x23½-ft. Dorr duplex classifiers in closed circuit with two 8-ft. by 48-in. tertiary Hardinge ball mills. The overflow from the tertiary classifiers (89 per cent minus 200 mesh) goes direct to the flotation surge tanks mentioned previously.

The ball mills are direct-driven through a rope drive, a 250-hp. motor furnishing power to each primary unit, and a 150-hp. motor to each secondary and tertiary unit. Ball load, (3-in. and



LEAD AND ZINC sulphides are recovered separately as concentrates in the mill, following this flowsheet. The individual units are described in the legend above

LEGEND

1. Receiving bin; capacity 1,800 tons
2. Surge bin, delivers to four 4x5-ft. Hummer screens. Bypass bin, used when Symons is down, delivers to chutes thence by conveyors to rolls
3. Symons cone crusher, 7 ft. diameter
4. Two sets 74x20-in. Allis-Chalmers rolls (Garfield type)
5. Fine crush bin (steel); capacity 5,000 tons
6. Fine crush bin (concrete); capacity 3,700 tons. Both bins serviced by bedding machines.
7. Six Merrick Weightometers
8. Six 10x48-in. Hardinge mills, ball load 23 tons each, and three Dorr double duplex classifiers, 16x20 ft.
9. Ten Dorr duplex classifiers, 6x25 ft.
10. Eleven Akins classifiers, 6-ft. spiral
11. Four 8 ft. by 48 in. Hardinge mills, load 17 tons. Four 10 ft. by 48 in. Hardinge mills; load 25 tons
12. Seven Dorr duplex classifiers, 6 ft. by 23 ft. 6 in.; one 30-ft. and one 20-ft. surge tank
13. Two 8 ft. by 48 in. Hardinge mills; ball load 17 tons. Two 18½-ft. diameter sumps
14. Twelve 16-cell "Sub A" M.S. machines. Lead roughers, Nos. 1-12
15. Ten 16-cell "Sub A" M.S. machines. Zinc roughers, Nos. 21-23, 25-28 and 30-32. Four 8-cell "Sub A" M.S. machines. Lead cleaners, Nos. 24 and 29, split.
16. One 6x25-ft. Dorr duplex classifier
17. One 8 ft. by 18 in. Hardinge mill
18. One 10-ft. bowl classifier.
19. Four 10-cell "Sub A" M.S. machines, Zinc cleaners, Nos. 41, 42, 45, and 46. Two 10-cell "Sub A" M.S. machines. Lead recleaners, Nos. 43 and 44
20. One 60-ft. Dorr traction thickener (water reclamation)
21. Two 10-cell "Sub A" M.S. machines. Zinc re-treatment, Nos. 51 and 52 Two 10-cell "Sub A" M.S. machines. Zinc recleaners, Nos. 53 and 54
22. One 30-ft. surge tank
23. Two 50-ft. Dorr thickeners (one lead and one zinc)
24. Two 20-ft. stock tanks (one lead and one zinc.
25. Two 8x12-ft. Oliver (lead) filters
26. Five 6-ft. American (zinc) filters, six leaf

2-in. balls) is 23, 17 and 25, and 17 tons respectively. The mills are lined with chrome-nickel cast liners, and rubber launders and rubber bends are used exclusively in the pulp distribution system. Liner wear is about 0.1 lb. per ton, and ball consumption 1.25 lb. per ton of ore treated. Following are the amount and type of reagents used in the tertiary grinding circuit: Sodium cyanide, 0.05 lb.; sodium carbonate, 0.75 lb.; water-gas tar, 0.10 lb.; creosote, 0.038 lb.; and cresylic acid, 0.015 lb. per ton of ore treated.

The pulp in the flotation surge tanks (density from 36 to 40 per cent) goes to the lead rougher circuit, consisting of twelve 16-cell M.S. Sub-A flotation machines. Both tanks are equipped with stirring mechanisms and serve as conditioners and distributors. Concentrates produced by 12 cells of each rougher machine (30 to 32 per cent lead) are cleaned in four 8-cell M.S. Sub-A machines (two 16-cell units split), and middlings from the last four cells are returned to the secondary grinding circuit. About 50 per cent of the rougher tailings pass through a 50-ft. Dorr thickener, where the density of the pulp is raised from 26 to 60 per cent, before they enter the zinc rougher machines.

Reclaimed water is pumped back to the head of the mill. Concentrates from the four cleaner units (about 55 per cent lead) are recleaned in two 10-cell M.S. Sub-A machines, producing a product assaying 70 per cent lead, 4½ per cent zinc, 6½ per cent iron, 22 to 24 oz. silver, and less than 1 per cent insoluble, and tailings (18 per cent lead) are pumped back to the secondary classifiers. Final lead concentrates pass to a 50-ft. Dorr thickener, with the underflow going successively to a 20-ft. stock tank and two 8x12-ft. Oliver filters. Recleaner tailings, carrying about 45 per cent lead, return to the heads of the cleaners.

THE CONCENTRATOR of the Consolidated Mining & Smelting Company at Kimberley, B. C., is situated about two miles from the crushing plant, which is at the portal of the 3,900-ft. level tunnel. It is treating 6,500 tons daily of ore running 10 per cent lead and 7 per cent zinc

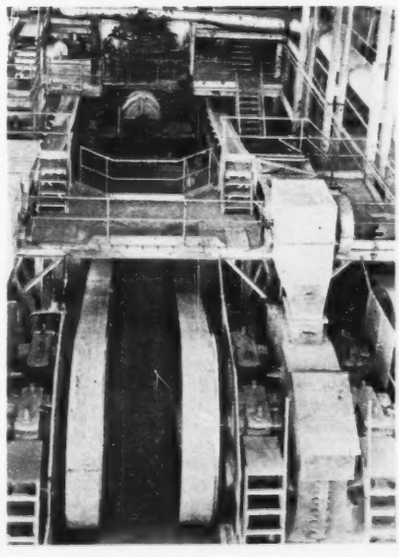
The reagent set-up in the lead flotation section is as follows: About 0.11 lb. sodium ethyl xanthate and 0.10 lb. calcium oxide are added at the first cell of each rougher machine; 0.05 lb. sodium ethyl xanthate is added at the sixth cell; and 0.089 lb. sodium ethyl xanthate, 0.12 lb. water-gas tar, 0.046 lb. creosote, and 0.018 lb. cresylic acid are added at the thirteenth or first cell producing middlings. At the cleaner units 0.014 lb. sodium ethyl xanthate, 0.045 lb. water-gas tar, 0.017 lb. creosote, and 0.007 lb. cresylic acid are added at the head of each machine. The first cell of each recleaner machine receives 0.0061 lb. sodium ethyl xanthate, 0.0014 lb. water-gas tar, 0.0005 lb. creosote, and 0.0002 lb. cresylic acid. Figures are in pounds per ton of ore.

Tailings from the lead roughers going to the zinc circuit average 1.5 per cent lead and 7 per cent zinc. All machines used there are of the same make as those in the lead circuit—namely, M.S. Sub-A units. There are ten 16-cell roughers, four 10-cell cleaners, two 10-cell recleaners, and two 10-cell retreatment units. Eleven cells of each rougher machine produce concentrates containing 35 per cent zinc, and the remaining 5 cells a middling product, which is delivered to a regrind unit consisting of an 8-ft. by 48-in. Hardinge ball mill operating in closed circuit with a 6x25-ft. Dorr duplex classifier and a 10-ft. Dorr bowl classifier. Rougher tailings carrying 0.6 per cent lead, 0.4 per cent zinc, and 44 per cent iron go to waste; and the concentrates are sent to the cleaners. These produce concentrates assaying 45 per cent zinc. The tailings join the middlings from the rougher unit going to the regrind unit. Cleaner concentrates, in turn, go to the recleaners, which produce a final product containing 51 per cent zinc, 3.2 per cent lead, 11.5 per cent iron, and 0.5 per cent silica. The tailings from the recleaner units are pumped back to the heads of the cleaners. Final concentrates go to a 50-ft. Dorr thickener, the underflow receiving subsequent treatment in a 20-ft. stock tank, six American filters (6 levels), and a rotary dryer.

Overflow from the regrind classifiers passes to a 20-ft. surge tank delivering to the first re-treatment machine, whence concentrates are returned to the zinc cleaners and tailings to the second re-treatment unit. Middlings from this machine are sent to the regrind classifiers, and tailings go to waste. Reagents, consisting of 0.055 lb. sodium ethyl xanthate, 0.34 lb. calcium oxide, and 0.50 lb. copper sulphate, are added at the first cell, and 0.034 lb. water-gas tar, 0.013 lb. creosote, and 0.005 lb. cresylic acid to the twelfth cell of each rougher machine. About 0.127 lb. calcium oxide is added at the first cell of each cleaner; 0.018 lb. sodium ethyl xanthate and 0.0037 lb. creosote are added at the head of the first re-treatment unit; and 0.023 lb. copper sulphate is added at the regrind classifiers.

All reagents used in the concentrator are stored and mixed at a central plant, whence small centrifugal pumps transfer them to respective tanks in the lead and zinc flotation departments. One foreman and two helpers are responsible for mixing and proper distribution throughout the plant. Daily reagent consumption amounts to 4,800 lb. sodium carbonate, 3,675 lb. calcium oxide, 3,390 lb. copper sulphate, 324 lb. sodium cyanide, 1,905 lb. sodium ethyl xanthate, 1,950 lb. water-gas tar, 773 lb. creosote oil, and 300 lb. cresylic acid.

ROLLS and cone crusher in the fine-crushing department at the Sullivan mill



Ratio of concentration is 4 to 1, and total recovery of lead and zinc is 94 and 93 per cent respectively. Temperatures of the lead rougher pulp, zinc rougher pulp, lead and zinc cleaner and lead recleaner circuits, and zinc re-treatment circuit are 29, 30, and 35 deg. C., with about 12,000 lb. of live steam per hour being used for pulp heating. Wilfley sand pumps are used throughout the plant, but experiments are now being conducted with rubber-lined units. A relatively recent addition to the mill flowsheet is an emergency stock tank which is capable of holding a six-hour output of the lead department.

Sampling is done automatically wherever possible. In addition, examination of the zinc rougher tailings and re-treatment tailings, and of final tailings, is made every two hours, and hourly assays for grades and lead recovery are made by rapid methods of analysis at a small laboratory on the flotation floor. Final assays and research work are done at a well-equipped laboratory occupying the entire lower floor of the mill office.

Besides the office building, there are several fireproof structures housing the different repair shops, auxiliary offices, and spare machinery parts and materials. The power plant at the foot of the concentrator contains seven B.&W. boilers, each 318 hp., with automatic stokers, equipment for pulverizing coal, and three 1,500-kva. turbines that supply auxiliary power. The power purchased from the East Kootenay Light & Power Company is received at the mine and mill substations at 66,000 volts.

Some Hypothermal Gold Deposits

Near Bishop, Calif.

G. Austin Schroter
Geologist-Mining Engineer
315 West Fifth St.
Los Angeles, Calif.

Fig. 4 . . . DEPOSITION of sulphide minerals along flow cleavage, with replacement of both diopside and quartzite. South Fork, Bishop Creek. (Sulphides in solid black.)

IT AS SET FORTH *in Part I, published in the April number, Mr. Schroter has attempted to classify genetically a gold-bearing lode of the hypothermal type recently developed on property of the Cardinal Gold Mining Company. In the first installment, he discussed the physiography, general geology, stratigraphy, and structure of the occurrence. He concludes the study here, suggesting a temperature of formation at least as high as in the case of the Homestake orebody. Other areas along the lode outside the Bishop Creek mine may prove favorable for exploration, he thinks.*

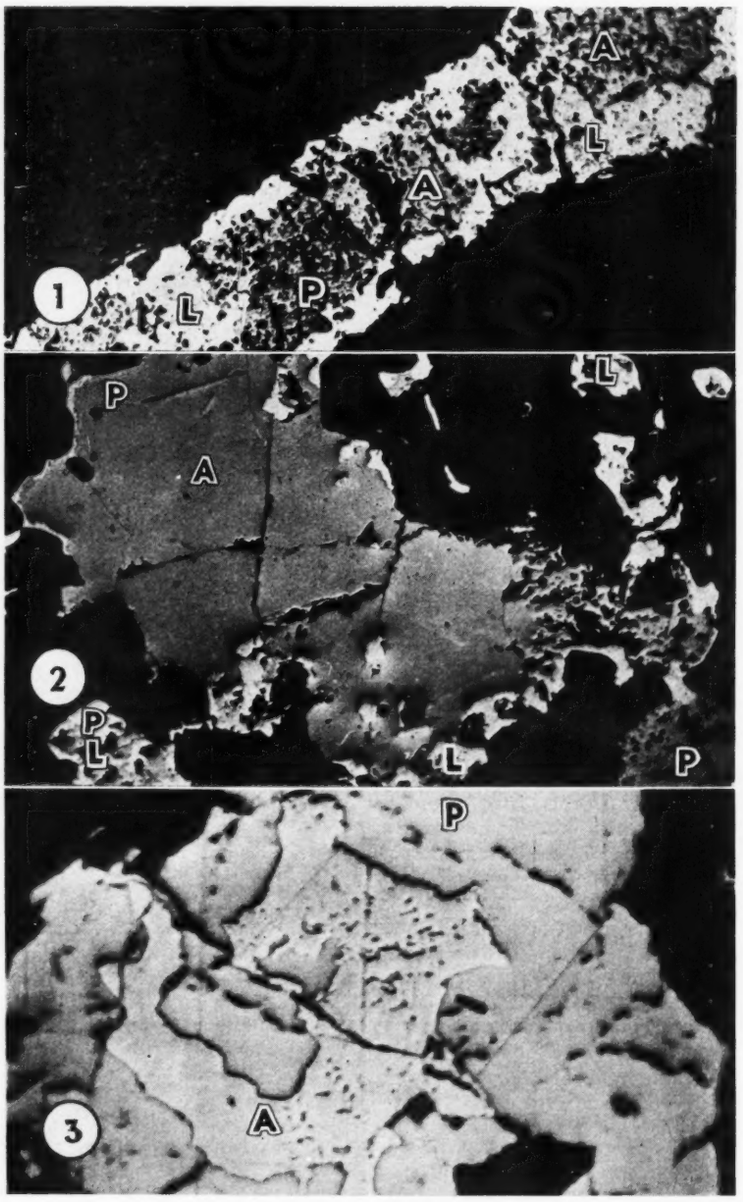
Mineralization and Paragenesis

EACH of the major geologic episodes of the district is reflected in the mineralogy of the Bishop lode, and the mineralogy is a rough check upon the geologic history. The earliest recognizable minerals, those characteristic of the sediments (or their metamorphosed equivalents), are sedimentary quartz and an occasional metacryst of biotite and orthoclase. The minerals of the second epoch (intrusion and pyrometasomatism) are, in the order of their importance, wollastonite, grossularite, quartz, and minor apatite, together with a weak pyritization. It is upon these earlier pyrometasomatic minerals that the commercial mineralization, together with the products of hydrometamorphism, is imposed.

The first stage of mineralization was the invasion of the metamorphic rocks by solutions which brought about a weak hydrothermal metamorphism. This stage is marked by a weak biotitization and a weak albitization.

The second stage was marked by the invasion of diopside with replacement of the quartzite, wollastonite, and earlier garnet. It may be pointed out here that pyroxenes are rare as hydrothermal minerals in this genetic class[2], although the amphiboles are relatively common. The only amphibole identified in the Bishop lode is minor tremolite, and its genetic assignment is uncertain.

In this connection it is interesting to note that in the Homestake mine,



1. ORE MINERALS deposited along flow cleavage plane. Lollingite (L) is replacing both arsenopyrite (A) and pyrrhotite (P). 2. Ore from the 200 Perry stope, Bishop Creek mine. Here lollingite is seen replacing arsenopyrite and itself in turn is replaced by pyrite. 3. Pyrrhotite is here shown replacing arsenopyrite in ore from the 400 Perry stope, in the Bishop Creek mine. All X 18

McLaughlin[2] recognizes the pre-ore formation of the critical amphibole, cummingtonite, which is often selectively replaced by ore minerals. In the Homestake, also, the distribution of sulphides conforms to the schistosity.

The mineral in the Bishop lode which may be roughly analogous to the Homestake cummingtonite is the pyroxene diopside, and inasmuch as McLaughlin believes that the presence of cummingtonite is essential for the precipitation of gold in the Homestake, the same rôle may be played by the Bishop lode diopside. Diopside is a prominent gangue mineral in all known oreshoots. The diopside stage was followed by a weak stage of garnetization, the garnet frequently showing crosscutting relationships with the diopside, but preceding the main commercial sulphide mineralization.

The sulphide mineralization was ushered in by a wave of arsenopyrite, possibly accompanied by minor pyrite and followed by a heavy pyrrhotite mineralization. The pyrrhotite was followed by relatively heavy deposition of the iron diarsenide, löllingite, which appears to replace both the arsenopyrite and the pyrrhotite. Pyrite replaces all three, and seems to have reached its heaviest period of mineralization after the löllingite stage.

After the main pyrite period, came minor chalcopyrite and bornite, followed by sphalerite and quartz, the later sulphides in minor amounts. Magnetite is rare and its position in doubt.

Cobalt, possibly as smaltite, occurs sparingly in the ore. Cobalt minerals have not been detected with the microscope, but the presence of this element is verified by analysis and by the characteristic blue color of smelter slags from Bishop Creek concentrates.

The genetic position and relationship of the gold is uncertain. Free grains have never been detected with the microscope, and it is thought to be in solid solution with pyrrhotite and arsenopyrite. Metallurgical studies show that the gold does not appear to favor either mineral preferentially, and the presence or absence of either of these sulphides is not critical in any given orebody. Löllingite may play an important rôle in this connection, as it is easily confused with arsenopyrite.

The oreshoots in the Bishop lode are definitely localized in lenticular zones in certain favorable horizons of the Sebrina complex. Oreshoots with stope lengths of as much as 300 ft. have been developed, and the mineralization detailed in the foregoing, without appreciable variation, is known to cover a vertical interval of better than 3,500 ft. Thirteen feet would be a fair average width for some of the oreshoots opened up in the Bishop Creek mine.

A consideration of the structural control, as well as the mineralogy, texture of the ore, and other field evidence, leads to the conclusion that oreshoots are localized primarily by certain pre-ore structures, and secondarily by replacement in certain zones of relatively soluble and porous rocks; that is, fractured quartzite and calcareous members now mapped as calcium silicates and ore. All of the evidence set forth in preceding paragraphs warrants the conclusion that these ore deposits are assignable to the hypothermal class, deposited under high temperatures and pressures.

Suggested Correlation—Any generalization regarding the correlation of these deposits with other hypothermal gold deposits of the world, from the standpoint of temperature, pressure, and depth of formation, is vulnerable to attack. Graton[1] points out that if the deposits of the Porcupine district, of the Homestake mine, of the Kolar field in India, and of Morro Velho, Brazil, were hypothetically placed in a vertical column of an aggregate vertical range of perhaps 50,000 ft., the depth sequence in the hypothermal zone, from shallow to deep, would be: Porcupine, Morro Velho, Kolar, and Homestake. This arrangement is based on the ideal, and must of necessity assume similar physical and structural characteristics in all of these deposits. Actually, the picture is modified by local variations in structure and host rocks. Accordingly, a deposit, the physical characteristics of which would indicate an apparent depth of 4 or 5 miles to account for temperature formation, may actually have been emplaced at

Critical Characteristics of Some Outstanding Hypothermal Deposits

Deposit	Mode of Occurrence	Wall Rocks	Structural Control	Ore Minerals	Gangue Minerals	Hydrothermal Metamorphism	Vertical Range, Ft.	Approximate Gold Content, Oz.
Bishop lode	Lode	Quartzites and schists	Flow cleavage, selective replacement, pre-ore breaks, intrusive contacts	Gold, pyrrhotite, arsenopyrite, pyrite, sphalerite, bornite, löllingite	Quartz, garnet, diopside, magnetite, albite, calcite, ankerite	Pyritization, albitization, bio-titization, "greisen," propylitization	+3,500	0.32
Homestake [3]	Ledges and pods	Cummingtonite schists, quartzites, slates, phyllites	Plunging anticlines, shear fracturing, flow cleavage, permeable rocks	Gold, pyrrhotite, arsenopyrite, pyrite, chalcopyrite	Quartz, ankerite, siderite, calcite, garnet, chlorite, magnetite	Propylitization, carbonitization	+2,900	0.18
Alaska Juneau	Stringer leads, lodes, lenses, and disseminations	Schists, slates, amphibolites	Irregular fracturing, cleavage, intrusive contacts	Gold, pyrrhotite, pyrite, galena, sphalerite	Quartz, ankerite, magnetite, tourmaline, biotite, muscovite	Albitization, biotitization, sericitization, ankeritization, silicification	+5,000	0.04
Hollinger [9]	*Lenticular, complex* "vein" systems	Keewatin lavas (schists in part), quartz porphyry, rarely	Fracturing and selective replacement along flow cleavage	Gold, pyrrhotite, arsenopyrite, pyrite, sphalerite, galena, scheelite, molybdenite	Quartz, ankerite, albite, tourmaline, clinozoisite	Biotitization, sericitization, pyritization, tourmalinization, carbonitisation	+4,400	0.35
Flin Flon, Manitoba, type [10]	Lenses in pre-ore shear zones	Schists, gneisses, greenstones, Keewatin lavas	Pre-ore shears	Gold, pyrrhotite, pyrite, chalcopyrite, sphalerite	Quartz, garnet, calcite, chlorite, amphibole	Propylitization, amphibolitization	.....	0.07
Appalachian [7]	Fissure veins and lenticular replacements	Schistose granites intrusive into schists, slates, amphibolites	Fracturing and selective replacement along flow cleavage	Gold, pyrrhotite, arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, molybdenite	Quartz, calcite, magnetite, garnet, tourmaline, albite, apatite, chlorite, dolomite	Pyritization, biotitization, tourmalinization, magnetization, silicification	+1,000	0.15
Morro Velho, [8] Brazil	Lode	Sericitic schists	Fracturing and fissuring (?)	Gold, pyrrhotite, arsenopyrite, pyrite, chalcopyrite, scheelite, wolframite	Quartz, ankerite, albite	Albitization, silicification	ankeritization,	+7,500 0.50
Broken Hill, [11] N.S.W.	Pressure and replacement, lenses	Schists, gneisses	Pre-ore drag faulting, flow cleavage, folding	Pyrrhotite, arsenopyrite, pyrite, chalcopyrite, sphalerite, galena, pyrargyrite	Quartz, garnet, calcite, magnetite, pyroxene, apatite		+2,200	....

depths considerably less than the apparent figure, owing to local impermeable barriers, or other factors tending to conserve the heat of formation. Likewise, the *vertical extent* of the hypothermal zone is a function of depth of intrusion of the mineralizing magma below the then-existing surface.

Some high-temperature deposits may be formed comparatively close to the surface, like certain rare tin deposits in rhyolite[3], but in general the concept of great depth is indicated. Such occurrences call for structural control different from the norm.

Some of the characteristic minerals of these deposits are dependent upon temperature alone[3], as the pyroxenes, spinel, and magnetite. Others, like tourmaline and topaz, require pressure and the presence of mineralizers for their formation, because of volatile constituents.

The whole subject of depth vs. temperature of formation of deposits in the hypothermal zone has been very ably discussed in recent years, especially by Butler and McKinstry, so that the observations just recorded are not offered as new contributions, but as a review of these concepts before trying to place the Bishop-lode type within the genetic classification.

In the Bishop lode, the crosscutting pre-ore intrusive masses may have served admirably as insulating barriers for the conservation of heat, and thus played a very important rôle in the formation of such high-temperature minerals as diopside.

On the other hand, the supposition of even a small amount of gouge along the zones of the crosscutting of even pre-ore faults, prior to ore emplacement, suggests channelways for the relief of pressure, and this fact, with the absence of tourmaline or other minerals containing volatile constituents, indicates that pressures were somewhat less than in some of the other deposits of the same genetic class.

Fracturing and fissuring, or either one, has played an important part at both Porcupine and Morro Velho; and flow cleavage and impermeable barrier are important factors in both the Homestake and Bishop lode.

Generally speaking, the structural and mineralogical evidence in the Bishop lode points to a temperature of formation at least as high as in the Homestake. Diopside at Bishop Creek suggests that the prevailing temperatures may have even exceeded those of the Homestake. Too little is known, however, about the characteristics of the formation of this mineral to accept it as a conclusive criterion.

A summary of the critical characteristics of a few outstanding hypothermal deposits is given in the accompanying table. All are gold deposits except that at Broken Hill, N. S. W.

Outlook for the Bishop Lode—To date, the Bishop Creek mine of the Cardinal company is the only operation on the Bishop lode, but the evidence indicates that large-scale mapping of the lode along the strike, especially of the relation of "soluble rocks" to the known structural control, may reveal loci for exploration as favorable as the ground in the Bishop Creek mine.

It has been proved, so far as development work has progressed, that the vertical range of the mineralization in the lode is at least 3,700 ft. The presence of complementary dikes in the ore zone, features frequently characteristic of the outer shell of magmas, as well as the fact that the large faults are open to circulation to the greatest depths penetrated, shows that not over a few hundred feet of the ore zone has been stripped away. The erosion figure, of course, is greater in the vicinity of ice channels.

The same petrography cannot be expected to continue in depth indefinitely, and because the orebodies appear to be related to distinctly metamorphic structures in a roof pendant, the bottoming of the pendant may be expected to be the bottoming of the ore.

I am indebted to A. J. Inderrieden, president of the Cardinal Gold Mining Company, and to the company itself, for permission to publish such parts of this paper as refer to the Bishop Creek mine, information which has been gathered largely at company expense. Appreciation is also expressed for the critical reading and constructive criticism of the manuscript by Dr. B. S. Butler, of the University of Arizona; Dr. and Mrs. Harrison Schmitt, of Hanover, N. M.; and Frank R. Wicks, of Los Angeles. The drawings and illustrations presented are by T. Calvert Slater; photomicrographs, by Charles A. Dawson, Jr.

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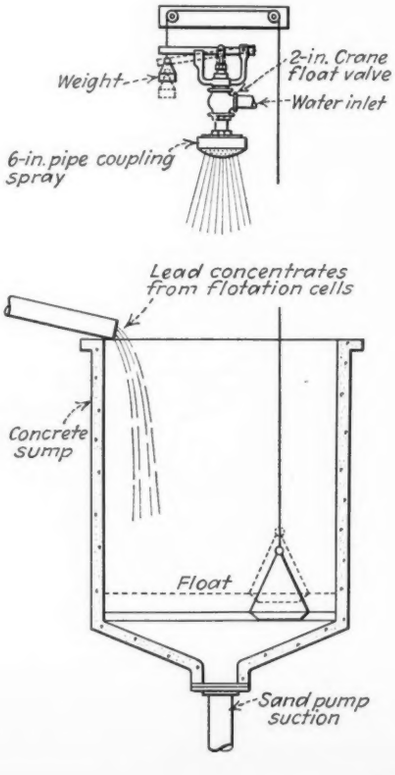
Pumping Flotation Concentrate

AT CONSOLIDATED Mining & Smelting Company's concentrator at Chapman Camp, B. C., final lead concentrates from flotation are first collected in a concrete sump and then pumped by a Wilfley sand pump to a 50-ft. Dorr thickener to be dewatered. The sump is circular, with a hopper bottom to which is attached the pump suction proper. Pumping was normal as long as no excessive frothing took place in the sump. When this occurred, removal of material from the sump either decreased or stopped entirely, and normal operations were attained only after the froth column had been washed down with a water hose.

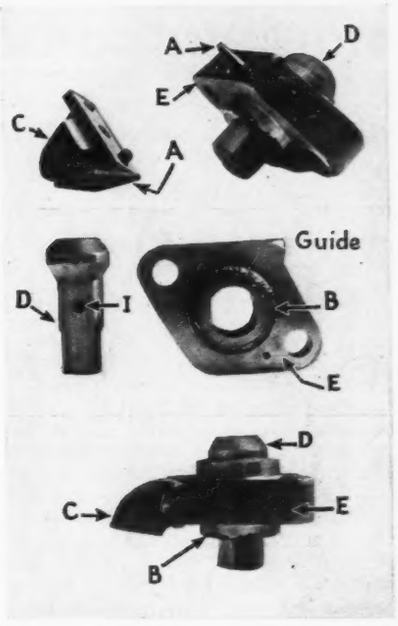


To keep the froth from rising to a height that would affect the pump delivery adversely, the mechanical department devised the automatic water spray shown in the accompanying sketch. It consists of a 2-in. Crane float valve with a weighed cross lever, two pulleys, a spray made from a 6-in. pipe coupling, and a steel float. Operation is simple. The advancing froth column simultaneously raises the float, which in turn releases the tension on the wire holding it and thus causes the weight to open the valve. Ths resulting water spray is stopped only after the float has been returned to its normal position by the receding pulp level. It is believed that the arrangement will work on any concentrate product provided sudden changes of density do not affect subsequent operations.

A Novel Water Connection For Stoper Drills

Simplifies construction, increases drilling speed, and makes cleaning easy

V. A. Brussolo
Superintendent of Mines
Pachuca District
Cia. de Real del Monte y Pachuca
Pachuca, Mexico



WATER CONNECTION for stoper drill devised in shops of Real del Monte company in Pachuca, Mexico. *A*, Rubber cone. *B*, Steel washer welded on anvil block guide. *C*, Water connection. *D*, Anvil block. *E*, Anvil block guide. *I*, Water inlet

AT THE MINES of Cia. de Real del Monte y Pachuca in the State of Hidalgo, Mexico, raising and practically all drilling of ore in stopes are done with hand-rotated stopers, of which about 400 are in operation at present. Though this type of drill was found most satisfactory for underground stoping operations, considerable trouble was experienced at times with water tubes. These would plug up frequently or would be broken or injured and have to be removed from the drill, either to clean or replace them, with consequent loss of drilling time. Also, in taking a drill apart an accessory part would often be lost or damaged, and unless this operation was done carefully and expertly, dirt and grit would find their way into the working parts of the drill, causing inconvenience and increased maintenance costs. Apart from these difficulties, the water tube frequently was responsible for water leakage into the drill-operating mechanism, thus affecting adversely its lubrication.

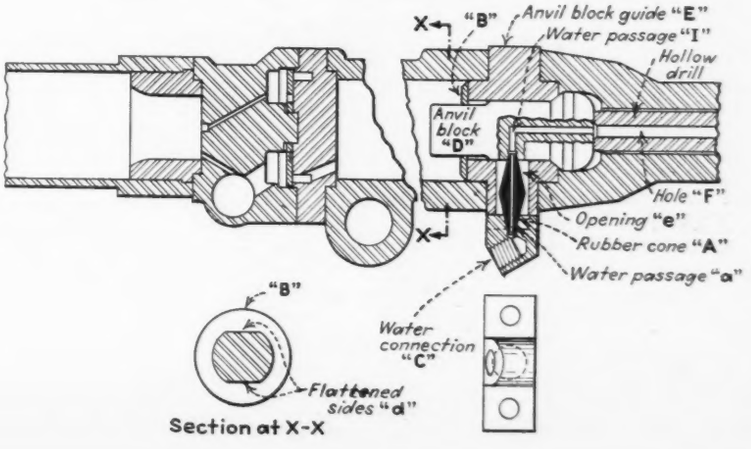
These inconveniences were satisfactorily overcome by a novel arrangement illustrated in the accompanying sketch and photographs. Explained briefly, instead of the water being introduced by the conventional water tube method, it is introduced at the upper end of the drill through the anvil block. The basic idea is not new; in fact it was tried some years ago but did not prove successful. The principal part of the arrangement to be described, however, is novel. It consists of a double-coned resilient member *A* made of rubber, which is $2\frac{3}{8}$ in. long, $\frac{5}{8}$ in. in diameter at the center, and tapering to $\frac{3}{16}$ in. at the ends. Through the center and for the entire length, a $\frac{1}{8}$-in. steel spring is vulcanized in place to add firmness to the rubber as well as to prevent the hole from being closed or deformed. One end of *A* fits closely into a water connection consisting of a plate bolted to the anvil block guide *E*. This connection is fitted to take a $\frac{3}{8}$-in. nipple from the water hose. The other end of *A* fits into a hole in the anvil block proper for a distance of $\frac{3}{8}$ in., the opening having the same taper as the rubber cone, which length is such that on bolting the water connection to the anvil block guide it is slightly compressed and a watertight seal thus made without the use of gaskets.

The anvil block guide contains a chamber $\frac{3}{4}$ in. in diameter, in which the rubber cone *A* moves freely and unhampered as it follows the reciprocating motion of anvil block *D*. This unit has a $\frac{1}{8}$-in. water passage as indicated. Maximum travel of the anvil block is about $\frac{3}{16}$ in. To prevent rotation of the anvil block, and in turn shearing of the end of rubber cone *A*, the lower end of the anvil block is provided with the two flattened sides *d*, $1\frac{1}{2}$ in. long, which fit closely into steel washer *B*, $\frac{1}{4}$ in. thick, welded to the bottom end of the anvil-block guide.

Advantages offered by the arrangement are (1) construction of the stoper drill is simplified to a great extent by elimination and modification of some accessory parts; (2) drilling speed is increased because of the greater effective area of the piston and absence of air leakages through the water tube hole (tests have shown a 10 per cent betterment of drill performance); (3) no water leakage is possible in the cylinder chamber; and (4) parts are easily cleaned and removed in case the water conduit is plugged up. The rubber cone *A* costs about 10c. United States currency, in contrast to 40c. for the conventional water tube, the life of the cone being about four times that of the metal tube. Moreover, when the tip of the cone resting in the anvil block becomes worn or broken, further service can be obtained by turning it end for end.

I am indebted to L. W. Emerson for suggesting the use of rubber and designing of the necessary modifications, and to E. W. Everheart and H. Buettel, superintendent of shops and rock-drill repair-shop superintendent, respectively, for valuable suggestions and construction of the drill parts.

STOPER DRILL in longitudinal section showing the novel water connection described. The device is advantageous in several respects



Summary of the

MARKETS

DESPITE a moderate flurry in sales that followed the President's announcement on April 15 of a new spending program aimed at reviving business, the record for the month was disappointing. Production and consumption continued out of balance and stocks in the hands of producers increased. Fortunately, most of the surplus metal is in strong hands and prices for the major items remained about steady. Domestic copper and lead prices were unchanged throughout April, but zinc and tin moved downward. The *E. & M. J.* index number of non-ferrous metal prices for April was 71.192, against 72.412 in March and 98.62 in April last year.

Domestic sales of copper for April totaled 22,790 tons, against 22,011 tons in March. Actual consumption of copper at the plants of fabricators has increased to about 41,000 tons a month. Owing to the fact that a good tonnage of domestic copper was sold during April for export, probably 10,000 tons, the price structure here was easily maintained on the basis of 10c. Valley.

Executives of foreign producers of copper arrived in London early in May to open discussions regarding the renewal of the agreement that expires July 1, 1938. The foreign agreement, taken as a whole, has been satisfactory, and leaders in the industry believe that it will be renewed without difficulty. Foreign demand for copper was good last month and prices showed little variation.

Lead sales here picked up sufficiently to support prices on the basis of 4½c., New York.

Zinc was under pressure in some directions and the price of Prime Western dropped to 4c., St. Louis, April 9. At that level some fair buying developed and the price quickly moved up to 4¼c. Toward the close, however, the price again weakened. An effort to revive the foreign Cartel failed.

Tin made a new low for the movement, on poor consumption, chiefly in the United States. Foreign silver held at 42⅜c. all month. Quicksilver and antimony were easier.

UNITED STATES MARKET

1938 Apr.	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St Louis	Zinc St Louis
1	9.775	9.150	38.975	4.50	4.35	4.15 @ 4.25
2	9.775	9.175	39.000	4.50	4.35	4.15 @ 4.25
4	9.775	9.200	38.750	4.50	4.35	4.15
5	9.775	9.250	38.250	4.50	4.35	4.15
6	9.775	9.250	37.850	4.50	4.35	4.15
7	9.775	9.275	38.000	4.50	4.35	4.15
8	9.775	9.275	38.750	4.50	4.35	4.00
9	9.775	9.275	39.000	4.50	4.35	4.00
11	9.775	9.400	39.150	4.50	4.35	4.00
12	9.775	9.450	38.500	4.50	4.35	4.00
13	9.775	9.525	38.750	4.50	4.35	4.00
14	9.775	9.575	38.750	4.50	4.35	4.00
15	9.775	9.600	39.250	4.50	4.35	4.00
16	9.775	9.650	39.250	4.50	4.35	4.00 @ 4.25
18	9.775	9.650	40.000	4.50	4.35	4.15 @ 4.25
19	9.775	9.725	39.000	4.50	4.35	4.25
20	9.775	9.600	38.625	4.50	4.35	4.25
21	9.775	9.500	38.375	4.50	4.35	4.25
22	9.775	9.525	38.625	4.50	4.35	4.25
23	9.775	9.500	38.750	4.50	4.35	4.25
25	9.775	9.500	38.250	4.50	4.35	4.25
26	9.775	9.525	37.650	4.50	4.35	4.25
27	9.775	9.525	37.500	4.50	4.35	4.15
28	9.775	9.525	37.300	4.50	4.35	4.15
29	9.775	9.450	36.625	4.50	4.35	4.15
30	9.775	9.450	36.250	4.50	4.35	4.15
For month Average	9.775	9.443	38.430	4.500	4.350	4.141
April			**AVERAGES FOR WEEK**			
6	9.775	9.188	38.471	4.500	4.350	4.183
13	9.775	9.367	38.692	4.500	4.350	4.025
20	9.775	9.633	39.146	4.500	4.350	4.138
27	9.775	9.513	38.192	4.500	4.350	4.233
April			**CALENDAR WEEK AVERAGES**			
2	9.775	9.208	39.371	4.500	4.350	4.233
9	9.775	9.254	38.433	4.500	4.350	4.100
16	9.775	9.533	38.942	4.500	4.350	4.021
23	9.775	9.583	38.896	4.500	4.350	4.242
30	9.775	9.496	37.263	4.500	4.350	4.183

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938 April	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.963750	4.956250	42.750	19.0000	140s. ⅛d	$35.00
2	4.963750	4.956250	(e)	18.8125	140s. 1d	35.00
4	4.965000	4.957500	42.750	18.8750	140s. ⅛d	35.00
5	4.965000	4.957500	42.750	19.1250	140s. ⅛d	35.00
6	4.961250	4.955000	42.750	19.0000	140s. 1⅛d	35.00
7	4.962500	4.955000	42.750	19.1250	140s. ⅛d	35.00
8	4.963750	4.957500	42.750	19.0000	140s. 1⅛d	35.00
9	4.961250	4.955000	(e)	18.7500	140s. 1⅛d	35.00
11	4.971250	4.965000	42.750	18.8750	140s. ⅛d	35.00
12	4.975000	4.968750	42.750	18.8125	139s. 10⅛d	35.00
13	4.976250	4.970000	42.750	18.8750	139s. 10d	35.00
14	4.985625	4.980000	42.750	18.9375	139s. 8d	35.00
15	4.997500	4.991250	42.750	Holiday	Holiday	35.00
16	5.005000	4.998750	(e)	Holiday	Holiday	35.00
18	5.006875	5.000625	42.750	Holiday	Holiday	35.00
19	5.001250	4.995000	42.750	18.9375	139s. 6d	35.00
20	4.983750	4.977500	42.750	18.8125	139s. 6d	35.00
21	4.988125	4.981250	42.750	18.8125	139s. 6⅛d	35.00
22	4.985000	4.978750	42.750	18.8125	139s. 6d	35.00
23	4.985000	4.978750	(e)	18.9375	139s. 7⅛d	35.00
25	4.990625	4.984375	42.750	18.8750	139s. 6d	35.00
26	4.987500	4.981250	42.750	18.9375	139s. 5⅛d	35.00
27	4.987500	4.981250	42.750	18.8125	139s. 7d	35.00
28	4.986875	4.980625	42.750	18.8750	139s. 6d	35.00
29	4.986250	4.979375	42.750	18.6875	139s. 6⅛d	35.00
30	4.986250	4.979375	(e)	18.5625	139s. 6⅛d	35.00
Average for Mo.	4.98046	.....	42.750	18.880	.....	35.00
April			**AVERAGES FOR WEEK**			
6	4.96396	.....	42.750	.....	.....	.....
13	4.96833	.....	42.750	.....	.....	.....
20	4.99667	.....	42.750	.....	.....	.....
27	4.98729	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver, April 2nd, 42.950; 9th, 42.750; 16th, 42.750; 23rd, 42.750; 30th, 42.750.

(e) Not quoted; Saturday.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.350c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout April.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938 April	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1	38.2500	38.5000	42.5000	171.0000	171.0000	15.5625	15.6250	15.5625	15.6250	13.5625	13.6250	13.8125	13.8750
4	38.9375	39.1875	42.7500	173.7500	174.0000	16.0000	16.0625	16.0000	16.1250	13.7500	13.8125	14.0000	14.0625
5	38.4375	38.6250	42.5000	168.0000	168.5000	15.6250	15.6875	15.6250	15.6875	13.5000	13.5625	13.6875	13.7500
6	38.5625	38.8125	43.0000	169.0000	169.7500	15.5000	15.6250	15.5625	15.6250	13.6875	13.7500	13.8125	13.9375
7	38.4375	38.6875	42.5000	167.7500	168.2500	15.1875	15.2500	15.2500	15.3125	13.3750	13.4375	13.5625	13.6875
8	38.4375	38.6875	42.5000	169.5000	170.0000	15.4375	15.5000	15.5000	15.5625	13.4375	13.5000	13.6875	13.7500
11	39.7500	40.0000	43.7500	173.5000	174.5000	16.1250	16.1875	16.1250	16.1875	13.8125	13.8750	14.1250	14.1875
12	39.4375	39.6875	43.5000	170.0000	170.7500	16.0000	16.0625	16.0000	16.0625	13.6250	13.6875	13.8750	13.9375
13	39.9375	40.2500	44.0000	170.7500	171.5000	16.1875	16.2500	16.1875	16.2500	14.0000	14.0625	14.2500	14.3125
14	39.8125	40.1250	44.2500	170.0000	170.7500	15.8750	15.9375	15.8750	15.9375	14.0625	14.1250	14.3125	14.3750
15	.....	.....	.....	.....	.....	.....	Holiday	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....	Holiday	.....	.....	.....	.....	.....	.....
19	40.1875	40.4375	44.5000	170.7500	171.5000	15.6250	15.6875	15.6250	15.6875	13.8750	13.9375	14.0625	14.1250
20	39.9375	40.2500	44.0000	170.0000	170.7500	15.7500	15.8125	15.7500	15.8125	13.9375	14.0000	14.1250	14.1875
21	39.5625	39.8125	43.5000	168.7500	169.2500	15.5625	15.6250	15.5625	15.6250	13.8125	13.8750	14.0000	14.0625
22	39.5625	39.8750	43.5000	167.7500	168.5000	15.5000	15.5625	15.5000	15.6250	13.8750	13.9375	14.0000	14.0625
25	39.4375	39.6875	43.5000	167.6250	168.2500	15.2500	15.3125	15.3750	15.4375	13.7500	13.8750	13.9375	14.0000
26	39.5000	39.7500	43.7500	165.0000	166.0000	15.0625	15.1250	15.1875	15.2500	13.5000	13.5625	13.6875	13.7500
27	39.6875	40.0000	43.5000	164.5000	165.2500	15.0000	15.0625	15.1250	15.1875	13.5625	13.6875	13.6875	13.7500
28	39.7500	40.0625	44.0000	164.5000	165.0000	15.1875	15.2500	15.3125	15.3750	13.6250	13.6875	13.6875	13.7500
29	39.1875	39.5000	43.2500	161.5000	162.2500	14.9375	15.0000	15.0625	15.1250	13.4375	13.5000	13.5000	13.5625
Average for month	39.306	.....	43.408	168.612	.....	15.579		15.623		13.729		13.919	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated
(May 2, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb ..... 13.250c.
Bismuth, ton lots, lb $1.05
Cadmium, lb ..... 85c. @$1.20
Calcium, lb., ton lots 98 @ 99 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carloads, lb ..... 30c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $36.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $70.00@$71.00
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $2.00
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb ..... $1.75@$2.00
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $6.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $24.00@$26.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
Old Range bessemer $5.25
Mesabi bessemer $5.10
Old Range non-bessemer $5.10
Mesabi, non-bessemer $4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton $49.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
52 @ 55 per cent ..... 43c.
50 @ 52 per cent ..... 43c.
44 @ 48 per cent ..... 38c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
Chinese duty paid ..... $21.00@$22.00
Domestic, 70 per cent and upward ..... (a) $17.00@$19.00
Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $27.00 (a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.25
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb $1.42
Sodium Sulphate, bulk, ton ..... $13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Bé, per lb. of contained Bé $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $102.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained. 95c
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained ..... $1.80@$1.85

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:
Canadian (Quebec)
Crude No. 1 ..... $700@$750
Crude No. 2 ..... $150@$350
Spinning fibers ..... $110@$200
Paper stock ..... $40@$45
Shorts ..... $12@$16.50
Vermont
Shingle stock $57
Paper stock $40
Cement stock $25
Barytes, long ton:
Georgia, crude $7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.60
Bauxite, long ton:
Domestic, chemical, 55 @ 58 per cent ..... $6.50@$7.50
Domestic, abrasive, 70 @ 84 per cent ..... $12.50@$15.00
Dalmatian, 50 @ 55 per cent ..... (a)$6.50@$7.50
French, 56 @ 59 per cent ..... (a)$8.00@$9.00
China Clay, f.o.b. mines, ton:
South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
Delaware, No. 1 ..... $14.50@.....
Feldspar, bulk, ton:
Potash feldspar, 200 mesh $17.00
Glass-spar, white, 20 mesh $11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton ..... $18@$19
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
Dead-burned, f.o.b. California ..... $25.00@.....
Dead-burned, f.o.b. Washington ..... $25.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:
1½ x 2 in ..... 15@40c.
2 x 2 in ..... 30@60c.
3 x 3 in ..... 75@$1.20
3 x 4 in ..... $1.00@$1.40
4 x 6 in ..... $2.00@$2.50
White, ground, 70 mesh, ton ..... $60.00@$80.00
Ocher, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, water-floated, in bags, 325 mesh, ton ..... $16.00@$40.00
Sulphur, Texas mines, long ton ..... $18.00@.....
Talc, f.o.b. works, ton:
New York, double air-floated, 325 mesh ..... $12.00@$15.00
New Jersey, mineral pulp ..... $8.00@$10.00
Vermont, extra white, 200 mesh ..... $9.00@ $9.50
Tripoli, Missouri, ton:
40 mesh, cream colored ..... $15.00@.....
200 mesh, cream colored ..... $25.00@.....
(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
Bessemer $24.50
Basic $23.50
No. 2 Foundry $24.00
Steel, base prices, Pittsburgh:
Billets, gross ton $37.00
Structural shapes, 100 lb $2.25
Bars, 100 lb $2.45

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	42.750	20.740	18.880	491.524	498.046
May	45.025	.....	20.346	.....	493.835	.....
June	44.818	.....	20.022	.....	493.404	.....
July	44.750	.....	19.986	.....	496.582	.....
August	44.750	.....	19.848	.....	498.043	.....
September	44.750	.....	19.889	.....	495.145	.....
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	9.775	14.692	9.443	62.506	39.306	66.614	43.408
May	13 775	.....	13.999	.....	61.118	.....	63.684	.....
June	13.775	.....	13.492	.....	55.696	.....	61.409	.....
July	13.775	.....	13.817	.....	56.412	.....	62.807	.....
August	13.775	.....	13.926	.....	57.143	.....	63.595	.....
September	13.530	.....	12.984	.....	52.989	.....	58.966	.....
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1937	1938	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	4.500	6.025	4.350	26.014	25.878	15.579	15.623
May	6.000	.....	5.850	.....	24.000	23.891	.....	.....
June	6.000	.....	5.850	.....	22.878	22.759	.....	.....
July	6.000	.....	5.850	.....	23.932	23.703	.....	.....
August	6.452	.....	6.302	.....	22.606	22.670	.....	.....
September	6.400	.....	6.250	.....	20.990	21.044	.....	.....
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	38.430	267.136	168.612
May	55.651	.....	250.645	.....
June	55.851	.....	249.852	.....
July	59.245	.....	263.540	.....
August	59.465	.....	264.595	.....
September	58.675	.....	258.943	.....
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	4.141	26.216	26.344	13.729	13.919
May	6.750	.....	23.092	23.365	.....	.....
June	6.750	.....	21.409	21.528	.....	.....
July	6.923	.....	22.568	22.693	.....	.....
August	7.192	.....	24.140	24.290	.....	.....
September	7.190	.....	21.406	21.607	.....	.....
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	102.500	20.000	20.000
May	105.000	.....	20.000	.....
June	130.962	.....	20.000	.....
July	142.500	.....	20.000	.....
August	142.500	.....	20.000	.....
September	142.500	.....	20.000	.....
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound, average of producer's and plater's quotations.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	13.654	92.000	71.019	58.000	36.000
May	14.830	.....	95.520	.....	54.800	.....
June	14.702	.....	96.654	.....	53.000	.....
July	14.803	.....	93.904	.....	50.115	.....
August	15.327	.....	91.423	.....	51.000	.....
September	16.555	.....	89.020	.....	51.000	.....
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	24.50	23.50	23.50	24.00	24.00
May	24.50	.....	23.50	.....	24.00	.....
June	24.50	.....	23.50	.....	24.00	.....
July	24.50	.....	23.50	.....	24.00	.....
August	24.50	.....	23.50	.....	24.00	.....
September	24.50	.....	23.50	.....	24.00	.....
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

A. Chester Beatty is spending a vacation in Egypt.

Irvin E. Rockwell has been elected president of the Idaho Mining Association.

W. F. Allen, Jr., is now general superintendent at Alta Mines, Inc., at Ophir, Colo.

C. E. Poirier, mining engineer, announces the removal of his office to 49 Wall St., New York City.

Sydney H. Ball, of the firm of Rogers, Mayer & Ball, is in the West on a short professional examination.

E. Hogan Taylor, general manager of Burma Corporation, Ltd., operating at Namtu, Burma, is visiting Australia on leave.

E. L. Sweeney, construction engineer of Denver, has been in Nevada mining districts where he has built mills in late years.

Carl A. Geist, of Cincinnati, Ohio, assistant treasurer of the Eagle-Pitcher Lead Company, has been elected vice-president of the company.

L. C. David, assistant manager of Minnesota Mines, Pickands-Mather Company, at Hibbing, Minn., is vacationing in the East.

Arch. J. Tourtellotte, of Portland, Ore., was in New York last month. He is operating Klery Placers, Inc., in the Kobuk mining region of Alaska.

Gomer P. Jones was recently elected chairman of the Vancouver Branch of the Canadian Institute of Mining and Metallurgy, succeeding **R. R. Hedley.**

Frank Ayer, general manager of Roan Antelope Copper Mines and Mufulira Copper Mines, has been spending a short vacation in the United States.

R. V. Hopper, manager for Belleterre Quebec Mines, Ltd., has returned to Canada after completing a private examination of manganese properties in Porto Rico.

Leslie Bradford, general manager of the Broken Hill Proprietary Company, has been awarded the Medal for 1937 of the Australasian Institute of Mining and Metallurgy.

Robert McClurkin, president of Matthiessen & Hegeler Zinc Company, and **H. D. Carus**, secretary of the company, spent several days in the Tri-State district early in April.

Norman J. Ericson, consulting engineer, of Manila, P. I., has returned to the United States for an indefinite period. He may be reached at 204 Moran St., Reno, Nev.

F. B. Daggett, formerly with the Chisos Mining Company, of Terlingua, Tex., has accepted an engineering position with Mammoth-St. Anthony, Ltd., Mammoth, Ariz.

William A. Simkins, engineer directing certain operations of the Newmont Mining Corporation at Grass Valley, Calif., has been inspecting gold properties in Nevada.

Willard Bayliss, of Chisholm, Minn., superintendent in the Chisholm district for the Oliver Iron Mining Company, was retired on April 1. He had been with the company since 1895.

Raymond Hurle, formerly with the Idaho-Maryland Mines Company, of California, has gone to Potosi, Bolivia, as assistant geologist for Cia. Unificada del Cerro de Potosi.

J. Wilbur Van Evera, of Crosby, Minn., has been elected president of the Alumni Association of the Michigan College of Mining and Technology, at Houghton, Mich.

Russel B. Caples, assistant general superintendent of the reduction department of Anaconda Copper Mining Company, at Great Falls, Mont., recently arrived in New York.

E. C. Bitzer is now metallurgist for Raub Australian Mining Company, at Raub, Pahang, Federated Malay States. He left the Philippines in February after about six years in the Islands.

E. C. Rice, formerly head of the engineering staff of Paracale de Oro has joined the International Engineering Corporation, and is stationed at Paracale, Camarines Norte, P. I.

George Kimber, active for years in mining districts of Nevada, has returned to that State from Calaveras County, Calif., where he worked a gold property during the winter.

Arthur Terry, managing director of Dorr-Oliver N. V., The Hague, sailed from New York for The Hague, Netherlands, on April 27, after a visit to his associates in the United States.

Harold Cogswell is assistant general superintendent at Demonstration Gold Mines, Ltd., in Baguio, P. I., a position recently created because of the growth of the operations of the company.

R. M. Murray, general manager of Mount Lyell Mining & Railway Company, Queenstown, Tasmania, left at the beginning of March on a trip abroad. During his absence **A. H. P. Moline** is acting as general manager.

M. F. Stansmore has resigned the position of mill superintendent of Sulphide Gold, Mandurama, N. S. W., to join the metallurgical staff of Cyprus Mines Corporation, Skouriotissa, Cyprus.

A. D. Marriott, manager of the metallurgical division of The Dorr Company, Denver, Colo., is visiting Australia and the East. He is at present making a tour of the principal Australian mining fields.

P. H. Zyderveld recently relinquished his position with Cia. Minera de Oruro. Bolivia, and is now assistant general manager for Bolivian Tin & Tungsten Mines Corporation, Casilla 158, Oruro.

Clifford Wendell, of Butte, Mont., has become geologist for Compania Huanchaca de Bolivia at Pulacayo, Bolivia. Mr. Wendell was formerly with Anaconda Copper. He sailed for Bolivia on April 9.

James M. McDonald is now manager of the Cariboo Hudson gold mine, Wells, B. C. He has acted in the past as mining engineer for the Kennecott, Granby Consolidated, and Bralco companies.

John C. Oliver, graduate of the University of British Columbia in civil engineering, has been appointed registrar of the Association of Professional Engineers of British Columbia at Vancouver.

Arthur Thomas, president of the Sierra Nevada, Ltd., operating at the north end of the Comstock lode in Nevada, has been at Salt Lake City, his former home, from his headquarters at Oakland, Calif.

Enoch Perkins returned to New York on the "Aquitania" on April 19, after a four months' trip, in the course of which he visited various points in Southern Rhodesia, the Transvaal, South Africa, and Turkey.

E. R. Tragitt, mining engineer, who for the past year had been receiver and superintendent of Silver Hollow Mines, Inc., at Compton, Ark., is now mine engineer for the London Mines & Milling Company at Alma, Colo.

E. P. Pfleider, mining engineer, is now employed at the plant of the Cuban Mining Company, Cristo, Oriente, Cuba, a subsidiary of the Freeport Sulphur Company, which has mining properties in Texas and Louisiana.

R. T. Elstead, of Chisholm, Minn., assistant superintendent in the Hibbing-Chisholm district for the Oliver Iron Mining Company, has been appointed assistant to the vice-president and will make his residence in Duluth.

Lucien Eaton has been appointed general manager of the Isle Royale Copper Company, which is about to resume production. He has been consulting engineer for the Copper Range company and Isle Royale for the past year.

Otto L. Erickson, president of Genie Boy Mines, Inc., and El Dorado, Inc., is supervising the operations of these two companies near Custer, S. D. **F. J. McCracken**, formerly of Powell, Wyo., is in charge of placer operations at the Genie Boy.

Merle H. Guise is examining placer gold properties on west coast of Vancouver Island, B. C., as well as the

narrow-vein lode gold properties at Zeballos, the new gold camp on the island. He can be reached through Union Club, Victoria, B. C.

Col. Percy E. Barbour has returned to New York from a two months' professional trip to Colombia.

T. C. H. Hewitt, formerly on the mining staff of Lake Shore Mines, Ltd., Kirkland Lake, is now with Western Mining Corporation, Ltd., with headquarters at Kalgoorlie, W. A.

A. P. Cortelyou, of the staff of the United States Vanadium Corporation, arrived in Manila early in April to spend about four months in the Islands. He will visit the various mining districts in the Islands for his company.

Glenville A. Collins, mining engineer, has returned to San Francisco from New York, where he spent several days in mid-April. This summer he expects to organize an expedition into the Zeballos area on the west coast of Vancouver Island, about 125 miles northwest of Victoria, B. C.

Martin Mahleen has been appointed supervising engineer in charge of RFC mine loans with headquarters in the Federal Reserve Bank Building, San Francisco. He succeeds **Thomas M. Bains, Jr.,** who now is superintendent of the Densmore mine near Columbia, Tuolumne County, Calif.

Chas. A. Mitke left San Francisco March 18 on the "China Clipper," for the Philippines, China, and Japan, for gold-mining interests. He arrived in Manila on March 24 to spend some months in consulting work for the Soriano interests at the Masbate Consolidated property.

G. T. H. McMahon has joined the staff of Raub Australian Gold Mining Company, Ltd., Raub, Pahang, F. M. S., as underground manager. He was recently at Tennant Creek, Central Australia, and was previously on the staff of Australian Mining Trust, Ltd.

V. V. Clark, placer mining engineer, has been appointed head of the mining engineering department of the University of the Philippines, and has already started his new duties. He came to the Islands about two years ago on consulting work.

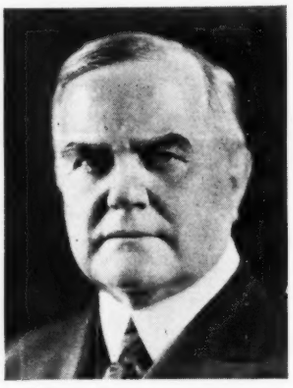
McHenry Mosier, of the mining division of the Bureau of Mines at Washington, D. C., was in the Tri-State district the latter part of April gathering data on mechanized mining methods. He was also interested in the length of service and causes of failure of hoisting cables.

Clayton Kissel, for many years one of the outstanding mining men of Colorado, has resigned as superintendent of the Ajax operation and has been succeeded by **Charles Carlton,** of Cripple Creek. Mr. Kissel was superintendent of the Portland before the Ajax became one of the Carlton properties.

Sidney J. McCarroll has resigned his positions as general superintendent of the Gregory-Bates Mining Company and mill superintendent of the Golden Gilpin custom mill, both of Black Hawk, Colo., to do metallurgical test work at the property of the Inca Mining Company, of Tirapata, Peru.

OBITUARY

Edward Joel Cornish, chairman of the board of the National Lead Company, was found dead at his desk in his office at 111 Broadway, New York, at 2:30 p.m. May 3. Death was caused by a heart attack. Mr. Cornish was 76 years old. He entered industry in 1903 as counsel for the estate of Levi Carter, who had been president of the Carter White-Lead Company. In 1908 he became a director of the National Lead Company and in 1916 its president. He was a director of the Chase National Bank, chairman of the board of Patiño Mines & Enterprises Consolidated, and a director of the Baker Castor Oil Company.



EDWARD JOEL CORNISH

S. W. Munsie, Minister for Mines in Western Australia, died in Perth on March 12, aged 67 years. A member of Parliament for the last 27 years, Mr. Munsie had been a member of every Labor Ministry since 1924, and performed outstanding work during his direction of the Mines Department.

(*Continued on page* 62)

Ira B. Joralemon, engineer and president of the Desert Silver Inc., has been at Edgemont, northern Elko County, Nev., where early-day gold producers have been acquired by the Bralorne Mines Ltd. of British Columbia, reputedly through Joralemon's instrumentality.

S. J. Clausen, Jr., who is now associated with private capital in the search for mining properties, is spending a large part of his time in Nevada and Arizona. Since returning from Mexico in February, he has opened offices at 302 Subway Terminal Building, 417 South Hill St., Los Angeles, Calif.

A. F. Ruimschotel, managing director of the Banka Tin sales offices of the Netherlands Indies Government, arrived in New York recently from Holland on the "Europa." During Mr. Ruimschotel's stay in New York he will make his headquarters at the offices of Tuthill & Company, American sales agents for Banka Tin.

N. A. Fittinghoff is now general manager of Masbate Consolidated Mining Company, in the Philippines; **T. H. Oxnam** is mill superintendent, and **H. H. Booker** mine superintendent. Mr. Fittinghoff and Mr. Oxnam assumed their positions in February. Mr. Booker has been running the mine department for some time.

Richard S. Eskridge, consulting mining engineer, of Seattle, Wash., has returned from Mexico after an absence of seven weeks devoted to the study of the geology of the La Paloma group of mining claims 25 miles east of Imurig, Sonora. Mr. Eskridge reports that as a result of the agrarian and expropriation situations, the business interests with which he came in contact fear a recession of some moment, although there seemed to be no feeling among Mexicans against foreigners in any part of the district in which he was working.

Gordon S. McDonnell is directing the development of the rich Privateer gold mine, in the Zeballos area, Vancouver Island, representing Connell Mining & Exploration Company, of Toronto, which has acquired a substantial interest. **Roy J. Maconachie,** of the engineering staff of the British Columbia Department of Mines, and formerly employed by Premier Gold Mining Company, has been stationed at Zeballos to aid in the development of that new gold-mining camp.

Cornelius F. Kelley, president of Anaconda Copper Mining Company, and **Carl T. Ulrich,** vice-president of Kennecott Copper Corporation, recently sailed to Europe to discuss with representatives of the copper industry there the renewal of the foreign Copper Cartel, which will expire on July 1 of this year. Renewal of the Cartel arrangement is expected by leaders in the industry.

William N. Fink, a mining engineer resident in Texas, general manager of Maguarachic Mining Company, operating 100 miles west of Chihuahua, Mexico, who had been held by the Chihuahua State police on a charge of complicity in the bomb asassination of Mayor Jose Borunda E., of Juarez, on April 1, was released on April 26. The issue which has developed because of the incident has become the subject of diplomatic exchanges between Mexico and the United States.

George P. Miller, formerly of the United States Bureau of Mines, is now connected with the Bureau of Mines of the Philippines, on a two-year contract. The Philippine Bureau of Mines now has five American engineers on its staff: **William F. Boericke,** valuation expert; **Russell C. Fleming, W. Benjamin Meek,** and **Dean Frasche,** mining engineers; and **Mr. Miller,** who will work on safety measures. **Dr. H. Foster Bain** is technical advisor on mining to President **Manuel L. Quezon** of the Philippines.

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(*Continued from page* 60)

R. R. Leslie, well-known San Francisco mining engineer, died recently at Marysville, Calif.

Herbert F. Widdecombe, consulting mining engineer, died in Denver, Colo., on March 17. He was 62 years old.

A. C. Borke, long on the staff of Lucky Joe mine of Le Roi Mines, near Jackson, Calif., died on Feb. 7 last.

John A. Weir, long identified with the mining industry of the West, died on Feb. 17 at Socorro, N. M.

Dr. Steven H. Worrell, first dean of the College of Mines at El Paso, Tex., and long active in Texas professionally, died on March 20 in Honolulu, at the age of 57.

Harry Allen Clark, manager of the smelter division of the Copper Queen branch of Phelps Dodge Corporation, died at Douglas, Ariz., on April 1 at the age of 67.

Fletcher H. Parsons, at one time assistant superintendent at the United Verde Copper Company plant at Clarkdale, Ariz., died at Bisbee, Ariz., on March 17.

Harry Clinton Goodrich, chief engineer for the Utah Copper Company and the Bingham & Garfield Railroad Company, died in Salt Lake City, Utah, on April 20 at the age of 70.

Dr. Francis Baker Laney, head of the department of geology of the University of Idaho since 1920, died on April 24 at the age of 63. Dr. Laney had been a prolific contributor to the reports of the United States Geological Survey and held degrees from the University of Wisconsin and from Yale.

Frank E. Berkenkotter, graduate of the University of Washington, died in Manila in March following an operation. He was the son of B. H. Berkenkotter, pioneer Philippine mining executive, and was on the staff of Eastern Syndicate Investment Company at the time of his death.

Sir Robert Williams, Bart., engineer, metallurgist, explorer, railroad builder, and an associate of Cecil Rhodes in the development of South Africa, died on April 25 at Drumoak, Aberdeenshire, Scotland. He was 78 years old. Sir Robert was intimately associated with the mining and railway development of South Africa, having been responsible for the construction of more than 3,000 miles of track in that continent. He was a vice-president of Union Minière du Haut-Katanga; chairman of Kentan

SIR ROBERT WILLIAMS, BART

Gold Areas, Ltd.; chairman of Kimingini Gold Mining Company, Ltd.; managing director of Rhodesia-Katanga Company, of Tanganyika Concessions, Ltd., and Zambesia Exploration Company, Ltd. He was the head of Sir Robert Williams Company, of London and South Africa. Belgium made Sir Robert a grand officer of the Ordre de la Couronne, and commander of the Ordre Royal du Lion. He was also a Knight Commander of the Order of Christ of Portugal. An appreciation of his colorful career and achievements was presented in the February 4, 1928, issue of *Engineering and Mining Journal.*

John Melhase, prominent California geologist and mineralogist, died at Redding, Calif., while on a field trip, at the age of 53. Mr. Melhase was first president of the California Federation of Mineralogical Societies.

Percy A. Robbins, mining engineer and economist and president of the Arctic Circle Exploration Company, engaged in mining operations at Candle, Alaska, died in Highland Park, Ill., on April 24 at the age of 64.

George M. Icard, pioneer mining man of Baguio, P. I., died in San Francisco on Feb. 4, after an extended illness. Mr. Icard came to the Islands in 1898, and after the close of the Spanish-American War went to Baguio. He prospected the district for some time, and worked with Benguet Consolidated during its early days. Later he devoted his time to new enterprises, and was instrumental in the organization of the Big Wedge Mining Company, King Solomon, Nayak, Gold Coin, and Icard Mines.

Norman B. Braly, mining engineer, and formerly manager of the North Butte Mining Company properties, at Butte, Mont., died recently at Palo Alto, Calif., aged 57. Mr. Braly, born near Sunnyvale, Calif., was graduated from Stanford University in 1905. After retiring from the North Butte Company, he became assistant to the president of Ahumada Lead Company, and later developed several coal land and business properties at Price, Utah.

▼

An Appreciation of Lauritz Dorenfeldt Jenssen

Lauritz Dorenfeldt Jenssen, generally hailed as the outstanding member of the Norwegian mining fraternity, died on Jan. 29th on his return from a trip abroad, only 56 years old. Educated at Trondhjem and Freiberg, Mr. Jenssen spent his first professional years with Sulitjelma Copper Mines. In 1913 he was called to Lökken works of Orkla Mining Company, where he soon rose to the highest executive position and where he remained until his death. During the difficult years through which the Norwegian mining industry passed in his time, first the post-War period and then the recent world-wide depression, Mr. Jenssen worked tirelessly to keep abreast and to modernize and rationalize methods and procedures. But his influence extended far beyond his immediate field of activity. Other mining companies, not only in Norway but also on the Continent, frequently drew upon his wide experience and thorough knowledge. He was a member of many public commissions and was several times called upon to lecture at the Norwegian Institute of Technology. For three years, from 1925 to 1928, he was even prevailed upon to fill the chair in mining methods, in addition to his regular duties. Always deeply interested in the humanitarian side of his work, he made Lökken a model community, with a modern hospital, fine cultural institutions, and numerous recreational facilities. His place will be difficult to fill.

BIRGER H. STROM

Letters

Testing for Molybdenum

The Editor:

HORACE F. LUNT'S criticism (*E.&M.J.*, March 1938, p. 64) of the article which appeared in the November issue on the determination of molybdenum is interesting, but I cannot agree with him on the points he has brought up. The procedure used in any test must be complicated enough to make it dependable, otherwise it falls into the category known as "slop tests."

Mr. Lunt states that the only element likely to interfere is iron, and if present the test can be re-run. As iron is present in practically all ores and alloys containing molybdenum, it seems logical to run the test with the assumption that it is present in all samples. The presence of copper will mask the test to an even greater extent than iron, which accounts for the use of sodium hydroxide as the precipitant rather than ammonium hydroxide, as Mr. Lunt suggests. The danger of decomposing the xanthate by overacidity is eliminated in the procedure originally given.

Using the procedure given in the article, the total time to run the test is only fifteen minutes, and to shorten this time by sacrificing dependability certainly is not in keeping with good laboratory practice nor is it a simplification when re-runs are necessary.

R. H. LOWE

What Metal Statistics Show

CONTINUED UNSETTLEMENT in general industry is becoming more keenly felt in mining districts, where producers of base metals view the large stocks of copper, lead, and zinc with increasing apprehension. Seasonal improvement in consumption of metals has been spotty, and far below expectations held earlier in the year. Producers have tried to maintain payrolls as much as possible during the winter months, building up these metal stocks which are now viewed by some in the industry as approaching an unwieldy stage under present conditions. Since business has failed to improve, producers are forced to curtail further, and some Western lead-zinc mines suspended operations early this month. More Government spending, coordinated with offers of business leaders to cooperate to bring about recovery, is held by many to augur some improvement later in the year.

Copper statistics for April are expected to show another increase in stocks. The trade believes copper in the hands of consumers amounts to about 100,000 tons, the lowest in some time.

Following is a summary of the February and March statistics of the Copper Institute, in short tons, covering foreign and domestic operations:

Production (blister):	Feb.	March
U. S. mine	43,342	43,463
U. S. scrap, etc.	7,362	12,467
Foreign mine	89,855	95,939
Foreign scrap, etc.	12,237	9,660
Totals	152,796	161,519
Production refined:		
United States	59,393	61,117
Foreign	101,957	108,704
Totals	161,350	169,821
Deliveries to customers:		
Domestic	27,389	33,434
Foreign	110,077	125,269
Totals	137,466	158,703
U. S. exports of domestic copper	4,893	11,142
Stocks, refined:		
United States	326,244	342,785
Foreign	203,609	197,467
Totals	529,853	540,252

Total deliveries amounted to 44,576 tons in March, consisting of 33,434 tons for domestic account and 11,142 tons for export. The exports were even larger than expected. Exports in the first quarter of 1938 totaled 21,859 tons, against 12,374 tons in the same period last year.

A monthly record of the United States duty-free copper statistics for all of 1937 and the first three months of 1938, in short tons, follows:

(Copper Institute)

	Blister Production	Refined Production	Refined Stock (a)
January, 1937	75,212	68,097	142,374
February, "	72,023	71,233	136,121
March, "	91,118	83,676	121,448
April, "	94,596	83,178	99,576
May, "	87,579	95,265	108,585
June, "	89,882	86,016	111,020
July, "	85,243	79,611	117,741
August, "	90,947	82,835	126,184
September, "	83,806	90,982	144,321
October, "	80,437	87,030	182,911
November, "	69,446	75,790	221,676
December, "	61,756	60,463	259,351
January, 1938	58,760	70,487	299,133
February, "	(b) 50,704	59,393	326,244
March, "	55,920	61,117	342,785

	Deliveries to Customers — Domestic	Export	Totals
January, 1937	80,812	5,979	86,791
February, "	74,610	2,876	77,486
March, "	94,830	3,519	98,349
April, "	95,884	9,166	105,050
May, "	81,336	4,920	86,256
June, "	77,725	5,856	83,581
July, "	67,356	5,534	72,890
August, "	68,019	6,373	74,392
September, "	66,229	6,616	72,845
October, "	43,742	4,698	48,440
November "	33,892	3,133	37,025
December, "	18,660	4,128	22,788
January, 1938	24,881	5,824	30,705
February, "	27,389	4,893	32,282
March, "	33,434	11,142	44,576

(a) Does not include consumers' stocks at their own plants or warehouses. (b) Corrected.

▶ LEAD—Stocks of refined lead in the hands of producers at the end of March totaled 143,511 tons, an increase of 5,377 tons for the month, according to the American Bureau of Metal Statistics. The addition to the surplus was about as expected.

Production totaled 36,436 tons, against 34,869 tons in February. The daily rate of production for March was 1,175 tons, which compares with 1,245 tons in February.

Domestic shipments for March amounted to 31,052 tons, against 30,135 tons in February, and 63,425 tons in March, 1937, the high for last year. Shipments in the first three months of 1938 averaged 32,037 tons monthly, against 53,172 tons monthly in the same period last year.

The statistics for February and March, in short tons, are summarized as follows:

	Feb.	March
Stock at beginning	133,401	138,134
Production:		
Domestic ore	33,555	35,129
Secondary and foreign	1,314	1,307
Totals	34,869	36,436
Domestic shipments	30,135	31,052
Stock at end	138,134	143,511

April statistics are expected to show another increase in lead stocks, as shipments to consumers are estimated to be between 27,000 and 29,000 tons. Seasonal improvement, expected earlier in the year, is apparently beginning in the building field, as lead producers note an encouraging demand for metal by pigment makers and sheet lead and pipe manufacturers.

▶ ZINC—Stocks of common grades of zinc increased during April, totaling 135,238 tons, an increase of 17,229 tons over March. Shipments to consumers in April were disappointing to the trade. They totaled 20,806 tons, the lowest since April, 1933. Stocks of Prime Western increased 9,078 tons and unfilled orders stood at 27,069 tons, a decline of 1,954 tons.

The March and April statistics of the American Zinc Institute, covering all grades, are summarized as follows in short tons:

	March	April
Production	43,399	38,035
Production, daily rate	1,400	1,268
Shipments	33,528	20,806
Stock at end	118,009	135,238
Unfilled orders	29,023	27,069

Statistics of the Prime Western division, common grades only, for March and April, follow:

	March	April
Stock at beginning	48,231	49,001
Production	22,404	20,868
Shipments	21,634	11,790
Stock at end	49,001	58,079

Silver Production of the World

Silver production for the world, by countries, for the six months ended February, 1938, in thousands of ounces, according to the American Bureau of Metal Statistics:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
United States	5,779	4,855	6,682	5,693	5,222	5,083
Canada	2,271	2,536	2,176	1,635	1,622	1,735
Mexico	6,460	6,112	6,272	5,760	8,662	(c)
Peru	1,260	1,150	1,225	1,400	1,500	1,351
Other America	1,650	1,650	1,650	1,625	1,640	1,520
Europe	1,600	1,650	1,675	1,750	1,670	1,570
Australia (a)	1,344	1,313	1,175	1,371	1,216	1,112
Japan (b)	820	800	800	800	820	820
Burma, refined	510	505	500	500	500	510
Other Asia	300	280	280	280	280	250
South Africa	93	94	92	96	96	90
Belgian Congo	350	350	350	300	300	300
Other Africa	50	50	50	120	75	75
Totals	22,487	21,345	22,927	21,330	23,603	....

(a) Includes New Zealand. (b) Owing to governmental interdiction the accounting for Japan is now necessarily on the assumption that it is being maintained about at prior rate. (c) Not yet reported.

CALIFORNIA

Operations Resumed at Oro Fino Mine

Shaft repaired following partial cave-in last year—Cyanide plants planned for mines in El Dorado and Amador County—Tullock mine being reopened

▶ The 300-ton mill at the Oro Fino mine, near Auburn, is in operation again following resumption of general mining operations. Production was suspended about a year ago when a cave-in necessitated the renovation of a large part of the three-compartment shaft. The property is owned by the Oro Fino Consolidated Mines Company, J. C. Kemp van Ee, president, and operations are directed by George Beck, superintendent.

▶ At the old Cloverdale quicksilver mine, 12 miles east of Cloverdale, Sonoma County, a 450-ton screening and concentrating plant is under construction by the Cloverdale Mining Company, to handle low-grade ore mined by steam-shovel methods from a large open pit. The final product will be treated in a rotary furnace available at the reduction plant. Operations are directed by G. H. Burr, Jr., president and general manager of the company, and the new unit is being installed by Western-Knapp Engineering Company of San Francisco.

▶ According to a report from Placerville, early construction of a 100-ton mill and cyanide plant at the Crystal mine, Shingle Springs, El Dorado County, is planned by the owners (New York interests). The property has been under development for several years, during which time a large tonnage of good milling ore has been blocked out. Benoni Lockwood, Jr., is superintendent.

▶ Construction of a cyanide plant for the treatment of flotation concentrates and tailings has been started at the property of Central Eureka Mining Company, Sutter Creek, Amador County, according to an announcement by C. C. Prior, president. Present operations are chiefly in the Eureka mine, where considerable milling ore has been opened as a result of development started about two years ago between the 2,500 and 3,000 levels. The company declared a 6c. dividend on Feb. 15. James Spiers, superintendent, is in charge of operations at Sutter Creek.

▶ Installation of hoisting equipment and a gravel-treatment plant consisting of a 30-ft. trommel, sluices, jigs, and rotary amalgamator has been completed at the Blue Channel mine, near Mokelumne Hill, by the Blue Channel Mining Corporation, Alfred Schmidt, president. The company also plans to exploit the High Line and Ounce Gulch holdings, and a dragline dredge is to be operated this summer to handle the shallow gold-bearing gravel at the Ounce Gulch property.

▶ A crew of 25 men is reported to be doing development work at the Del Norte claims in the Skidoo district, San Bernardino County, held under option by Lode Star Mining Company, operating at Mojave, Kern County, and in which Golden Queen Mining Company, W. C. Browning, general manager, a subsidiary of Gold Fields American Development Company, Ltd., has recently acquired a substantial interest. A camp has been built and exploratory work is under way.

▶ Seattle and Los Angeles interests are reopening the Tullock mine, near Angels Camp, owned by Mrs. L. Bisbee, of Angels Camp. Preliminary work in progress includes installation of mining machinery and unwatering and reconditioning of the shaft, which is 800 ft. deep.

▶ Development of territory below the bottom workings of the North Star mine, Grass Valley, is progressing satisfactorily, following sinking of a winze from the 9,600 level, with ore of good mill grade reported. The property is one of several mines operated by Empire Star Mines Company, Ltd., in the Grass Valley-Nevada City mining district. F. W. Nobs is general manager.

COLORADO

Shenandoah-Dives Aerial Tramway Being Repaired

Snowslide removed some towers and disrupted haulage system — New tailings ponds to be constructed in Alma-Fairplay district

▶ The steel towers on the Shenandoah Dives tramway that were swept away in a snowslide are now being reconstructed and should be completely replaced early in May. Charles C. Chase is general manager.

▶ The Summitville Consolidated Mines Company, controlled by the A. O. Smith Corporation, of Milwaukee, and located in the southwestern part of Colorado, recently made a rich strike on the 600-ft. level. Ore is treated in a 300-ton mill.

▶ New tailings settling ponds are being constructed in the Alma-Fairplay mining district, at a reported cost of about $18,000. Under the arrangement, mining operators in this district will impound their tailings before the water reaches the proposed dam. The purpose of the dam is to provide filtration. This tailings problem, especially in the Idaho Springs-Central City and Alma-Fairplay sections, has been a serious one, and caused a number of the properties to shut down temporarily and resort to heavy expense to impound their mill tailings.

▶ The mine operations in the Crestone area have shown a steady gain this winter. A reduced water supply forced the Alpine mill, which operates with water power, to close down for the winter, but development work has been pushed. Carl Cook, assistant manager of the L M B group on Cottonwood, is ready to start production in the Eastern Star property. Some Leadville mining men have leased the Old Barney McCarty mine, and are now examining the property. The Triple T mine recently installed a new 8-in. pump and expects to build a new mill this spring.

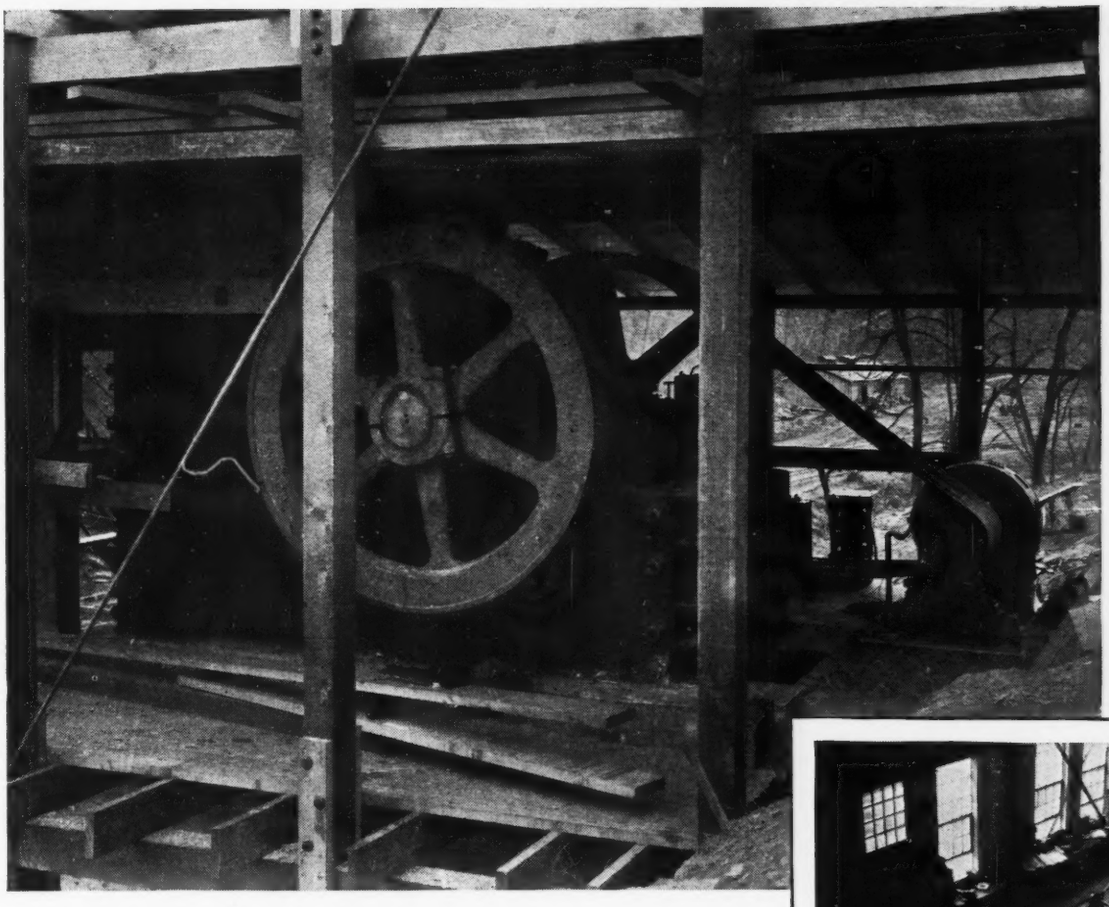
▶ If tungsten is not affected in the proposed trade agreement with the United Kingdom, activity in the Boulder district may increase. The Colorado Smelting & Refining Company mill at Marshall has installed a new set of rolls and an automatic sampler. E. P. Swerdferger is shipping tungsten ore from his Brock No. 5 mine to the Mining Associates mill at Salina. The Edgar Extension group have taken over the King group of tungsten claims. A. B. More is building a new tungsten mill at Wall Street, Boulder County, which will treat ore from the Paymaster mine. C. A. Staley, Jr., has opened a body of ore on the Livingstone mine, at Sugar Loaf.

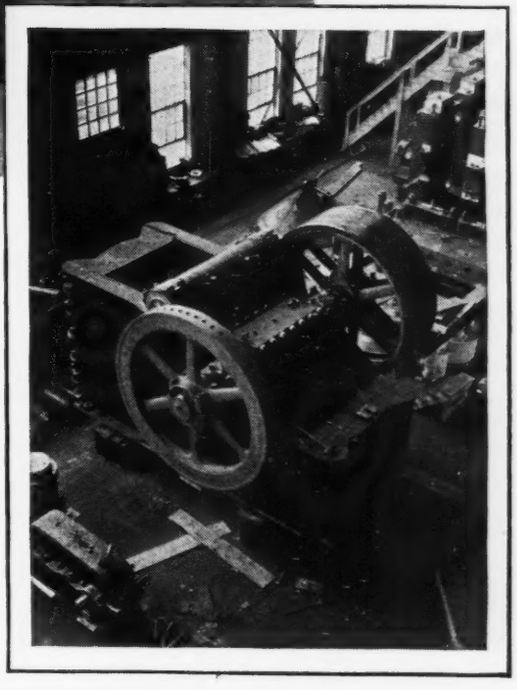
▶ New operations in the Ward district promise larger production this spring and summer. The Black Jack mine, on Upper Left Hand Creek, leased by Porter and Goodman, is producing lead-silver ore. The Boston Mine, leased by Strong Brothers, has been making steady monthly shipments. The Alaska group, on Sawmill Hill, will resume shipping as soon as weather permits. This property is operated by the Duwees Brothers. Golden Queen mine made the regular monthly shipment of high-grade ore. The Utica mines, at Ward, have been taken over by Hetzler and associates, and will produce ore for the new plant at Marshall.

▶ In the Empire district James A. Nisbet and Associates are operating the Gold Dirt mine. New drills, a compressor, and pumps have been installed, and work is being pushed for early shipments this spring. Jim Girardet has a group of men working the Calvin-Remington mine, on Seaton Mountain in Virginia Canyon. J. B. Firstenberg is now operating the remodeled Hoosaic mill on ores from the Metropolitan mine. The Idaho Bride mine is being worked by W. W. Murphy and Dick Nankervis. Ben T. Owens, working the Morning Star mine, recently shipped a car of high-grade ore.

▶ Ores that have been stored in the East Argentine district will be shipped soon to nearby mills as a large part of the new highway between Georgetown and Silver Plume is completed. A promising operation in this district is the Amy lode, a westerly extension of the Welch lode on Leavenworth Mountain. The Bruce mill is being replaced by the new mill for the Clear Creek-Gilpin tunnel enterprise at Dumont. American Smelting & Refining Company, at Alice, is milling about 265-tons per day. Mr. Arthur F. Johnson is general manager. The Black Bear Mines, Inc., operating the Mayflower and Lafayette group of mines, is preparing a shaft-sinking program. The Griffith Leasing Company has been repairing the Commonwealth mill, dewatering the shaft, and retimbering the tunnel.

▶ During 1937 the Climax Molybdenum Company made the following installations: New pumps were installed on the tailings pond and a new camp water supply system was built, involving purifying





Trouble free

From many of the 48 states, Alaska, Canada, Mexico and points beyond the sea, have come letters which pay tribute to the "TROUBLE FREE" operation of Birdsboro-Buchanan All-Steel Jaw Crushers.

Many years of rough usage—in hard to get at places—have proved the value of Birdsboro-Buchanan design and construction. Ease of assembly and dissembly has made it the favorite in remote locations. The special lubrication system keeps it running cool under the most trying conditions.

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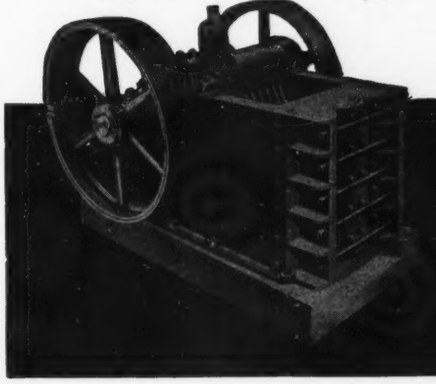

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apparatus, storage tanks, and pumps. New oil circuit breakers placed in the outdoor substations sectionalized the high-voltage distribution circuits. A new regrinding plant was installed. About one hundred new homes were constructed, and modern camp and street lighting systems were installed.

NEVADA

Large Water Line Being Laid to Placer Area

Gold dredge will later exploit property in Manhattan Gulch—Copper Canyon Mining Company plans construction of 300-ton cyanide plant

▶Under direction of engineers acting for the Natomas company, which owns a substantial interest in the project, the recently organized Manhattan Gold Dredging Company is laying a 12-mile line of 10- and 14-in. sheet-steel pipe from the Seyler ranch to placer ground in Manhattan Gulch, below the productive gold district in central Nye County. Water rights of the Seyler ranch were bought for $30,000. With completion of the pipe line a large-capacity gold dredge will be constructed and floated in the broad gulch.

▶Following an enforced shutdown of four months because of heavy snow and blocked roads, work has been resumed on the Jumbo gold property in the Awakening district, Humboldt County, with a force of 25 men under the management of G. W. Schilling, superintendent for the Hunt-Wadley group of Texas oil operators who last year acquired the property under a 30-year $10,000,000 option, with down payment of $250,000 to George B. Austin and members of his family. The second payment of $100,000 falls due late in May.

▶The Mountain City Copper Company, Elko County, controlled by the International Smelting Company, produced during the first ten months of last year a total of 29,551,777 lb. of copper while production was carried on at a capacity basis. During the last two months of the year, after a reduction, output was 3,441,992 lb. of copper. Gross returns from the sale of ore amounted to $2,711,952.93. Cost of mining, milling, smelting, refining, and transportation was $2,349,684.07. From this amount, $969,271.85 was deducted for copper held in stock. Deduction of this amount made the net cost of production $1,380,412.22. The company made one disbursement of 25c. at the end of the year, or a total of $592,631.75 on outstanding stock. Net income amounted to $1,059,298.67.

▶On property of the Copper Canyon Mining Company, southwest of Battle Mountain in Lander County, a new three-compartment shaft is being sunk and provision has been made for construction of a 300-ton cyanide mill to treat ore from the gold-bearing veins. These projects involve an estimated expenditure of $415,000. R. C. McCarty, manager, estimates the available reserve at 400,000 tons above the 350-ft. level, with indications of deeper enrichment.

▶Tests designed to perfect a process for the economic recovery of nickel from ore contained in deposits near Bunkerville, 7 miles from Lake Mead, in Clark County, have been conducted with an encouraging measure of success in the electro-metallurgical plant of the United States Bureau of Mines at Boulder City. Test runs were made on 60 tons of this ore, carrying, in addition to nickel, negligible quantities of copper, palladium, gold, and silver. R. G. Knickerbocker, in charge of the plant, said the ore was similar to that of the Sudbury, Ont., district. In final electrolytic smelting, the ore, after separation by flotation, is fluxed with quartz ore from mines in Eldorado Canyon, near the Colorado River.

▶Building gradually to a capacity operation, the new 600-ton cyanide mill and roasting plant of the Getchell Mine, Inc., in eastern Humboldt County, during the greater part of April treated around 400 tons per day with some minor interruptions due to mechanical adjustments. The roasting plant, a 100x7-ft. Gould rotary furnace, with baghouse unit and 80-ft. stack for the discharge of fumes, is now operating with success on sulphide ore containing a considerable amount of realgar. The overlying oxidized ore is mined by power shovel; the sulphide, 10 to 30 ft. wide on the footwall, is drawn from shrinkage stopes through a series of tunnels and transported to the mill bins by storage-battery locomotives. Bullion is poured every two weeks and shipped to the San Francisco mint.

▶Supplementing the supply of ore from its huge open cut on the outcrop of the Comstock lode, where caving of the west wall has caused interruption at times, the Arizona Comstock Corporation is mining a better-grade product from the surface of the Gould & Curry mine, adjoining its Savage mine on the north and acquired lately under lease. Underground work is being advanced in the company's Hale & Norcross and Chollar-Potosi mines. W. J. Loring is president and managing director.

▶Added equipment has increased to 300 tons per day the capacity of the scheelite concentrating mill of Gold, Silver & Tungsten, Inc., in the Nightingale district in western Pershing County. Alex Ranson, superintendent, and associates are operating a lease on the extension of the company's ore zone. A substantial tonnage of ore has been shipped to the concentrator of the Rare Metals Corporation at Toulon, operating as a subsidiary of the Nevada-Massachusetts Company, Inc., largest American tungsten producer.

▶A gasoline hoist, headframe timbers, and other equipment and supplies, delivery of which has been delayed by deep snow, were moved lately to property purchased by the Champlain Mining Company near the crest of the Gillis range in Mineral County and were being installed at the collar of a 105-ft. incline shaft sunk in a wide quartz vein. A short drift from the bottom of the shaft was said to show quartz carrying coarse free gold. On ground adjoining at the west, Dick Pledge and associates, of Hawthorne, have been extracting rich ore and native gold in coarse particles and in nugget form from narrow quartz seams in schist. They made one shipment of 26 oz. of gold to the mint at San Francisco.

▶In the Federal district court at Carson City, Judge Frank H. Norcross has approved a petition presented by Dryden Kuser, trustee in bankruptcy for the Como Mines Company and in reorganization proceedings involving that company. In a court order the company is authorized to exchange one share of new company stock for five shares of the bankrupt company and to dispose of unissued treasury stock, something over 1,250,000 shares, at not less than 10c. per share net to the company. The order grants certain broad exemptions from regulations of the Securities and Exchange Commission, but limits certain stock offerings to the State of Nevada. The 350-ton flotation mill at the Como mine was sold under foreclosure proceedings and was purchased by E. L. Cord and associates. Its equipment was included in a mill of similar capacity, completed lately at the Mary mine of the Black Mammoth Consolidated Mining Company at Silver Peak, in Esmeralda County, held under option by Cord and under the management of Fred A. Vollmar, Jr., who had acquired it and adjacent mines from the old Pittsburgh Silver Peak Gold Mining Company.

ARIZONA

Operations Suspended at Boriana Mine

Tungsten producer will resume when market conditions improve—Plato Mining Company takes lease on lead-silver property

▶The Molybdenum Corporation of America, which recently acquired the Boriana tungsten property and soon thereafter lost its mill by fire, has about completed a new and modern mill, but the market situation is such that the company has reduced the force at the mine to a minimum, and will not start the mill until there is more activity in the market. Only enough men to care for the property will be retained on the payroll.

▶J. M. Beach, of Los Angeles, has received court approval of a contract of sale and purchase from the court of Yavapai County to operate the Gold Bar mine. The old property will be unwatered and prepared for production.

▶Walter Lombardi, of Tombstone, and Fred Mayhugh, of Benson, recently made a discovery of cobalt ore. The ore was recognized by Jonathan Gordon, a mining engineer. Some sixty lode claims

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O'Brien Gold Mines
Siscoe Gold Mines
L. B. United Mines
Hollinger Mine
Shawkey Mine
Lonely Reef Mine
Little Long Lac Gold Mine
Gunnar Gold Mine
Jackson Manion Mine
Laguna Gold Mines
Bidgood Kirkland
Morris Kirkland
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have been made. An incline shaft has been sunk to a depth of 70 ft. It is reported the first 15 ft. passed through a nickel-cobalt ore and the remaining 55 ft. was through cobaltite.

▶ The Orizaba group of claims 23 miles southwest of Casa Grande has been taken over under bond and lease by the Plato Mining Company, Inc. Roy Ward, of Casa Grande, and G. A. Wilson, of Tucson, are owners of the property. Molybdenum, lead, and silver are found in the ore. A shaft 200 ft. deep has already been sunk on the property. The Plato company plans to do considerable diamond drilling to greater depths. Heretofore ores have been shipped to the Ray smelter. The new company is considering building a mill.

▶ The White Mountain mine, at Bouse, is shipping about a carload of barium ore daily by railroad to the California Talc Company. It is generally understood that the mine is being operated by the National Lead Company.

▶ A carload of mica is being shipped from the White Hope claims near Kirkland every month. The property is owned by Los Angeles parties and the work is in charge of Jim Regan. Shipments are expected to jump to 300 tons monthly under a contract recently consummated.

▶ Barmore Mines Corporation, financed by Texas capital, has started operation in the Tombstone district. It has taken a lease and option on 55 claims belonging to the Gallegher Vanadium & Rare Metals Corporation and the Mellgren Mines Corporation. The transaction includes the Gallegher mill, at Charleston, which is operating two shifts.

▶ A 40-ton mill is being installed at the Turning Point mine, 25 miles south of Casa Grande. Previous shipments of ore from this property have proved the necessity of reduction on the ground in order to cut transportation cost. The property is under control of A. M. Peck and C. S. McNatt, of Casa Grande.

▶ The old J. W. Lee property, in the Saddle Mountain district near Christmas, has been taken over by E. W. Schaffer, who is doing considerable development work.

▶ The large manganese holdings belonging to the Arizona Manganese Corporation in the Bill Williams Fork country, in the southern end of Mohave County, is continuing its exploration work under the direction of Ben N. Webber, of Phoenix, Ariz. About 15 men are employed. The property is under a long-term lease to the M. A. Hanna Company of Ohio.

▶ The Reymert mine, near Superior, is shipping about 1,200 tons of ore monthly to the smelter. W. J. Forbach, of Superior, is operating the property under lease.

▶ The Blue Bird mine, in Copper Creek, is being developed under the direction of Frank Fields. Eighteen men are now employed. The property carries values in copper, lead, silver, and gold. Irving K. Stone, of Battle Creek, Mich., is president of Blue Bird Mines, Inc.

▶ Another carload of gold ore averaging $60 per ton has been shipped from the Gray mine, near Hillside. The property is owned by P. C. and J. W. Lemons, of Hillside.

▶H. A. Savage, manager of the Lynx Creek Placer Mines Company, announces the installation of nine Bendelari jigs and the overhauling of the company's dredge at an approximate cost of $20,000.

▶ The property of the Hassayampa Gold Mining Company, in the Walnut Grove district near Kirkland, has been leased by J. E. Soper, of Gallup, N. M. This property has been in continuous operation for the past ten years and is said to have from 10,000 to 15,000 tons of commercial ore blocked out. It is understood the new lessee plans the erection of a 100-ton mill during the year.

▶ The 20-ton mill operating on the G. O. mines, in the Big Bug district near Mayer, is making an excellent gold recovery. The property is operated by Olsen and Grider.

▶ A new milling plant is being installed at the Sullivan mine, near Congress Junction. A small crew of men is employed. E. N. Beach, of Congress Junction, is in charge of the work.

▶ Bat Gays, of Superior, who has a controlling interest in the Silver King mine of that district, is doing considerable development. A small mill is planned for treatment of the old dumps. Mr. Gays expects to dewater the mine and continue exploration work.

▶ A sample shipment of gold ore has been made from the Mammon mine, south of Casa Grande, by the Wichita Mining Company, Inc., Arch S. Kincheloe, president. Further test shipments are to follow from the development work being undertaken. Tentative plans of the company include the construction of a 50-ton mill.

▶ The Chamber Chemical Company, Los Angeles, has resumed work on its aluminum silicate property 5 miles west of Quartzsite, Ariz. W. R. Fletcher is in charge of operations.

▶ The Union mine, 18 miles north of Phoenix, in the Winifred mining district, is under lease to Andrew J. Brengman, who is working a small force. The mine is the property of Sims Ely, of Boulder City, Nev., who recently received approval for a RFC loan of $20,000 but later decided not to accept it.

▶ Vivian Mining Company, operating near Oatman, is handling a considerable tonnage of custom ores since its recent installation of the cyanide process in its plant. The company has also changed from direct mining in its own properties to a leasing system. The mill is steadily in operation, and has a plentiful supply of ores in the bins.

▶ Arizona Magna Mining Company, of Chloride, has put some men to work on the Merrimac mine. A compressor has been installed and considerable exploration work is planned. Cliff Carpenter is president and general manager. The Magma mill still continues to handle the ores of the Magma mine, formerly known as the Diana, having run steadily for the past three years.

MICHIGAN

Activity Continues at Isle Royale Mine

Rehabilitated property about ready for production—Copper Range Company increases mineral land holdings

▶ After several months of rehabilitation work, stoping in Isle Royale will soon be resumed. The water in No. 4 shaft has been lowered to the 29th level, and timber repairs are proceeding in both Nos. 4 and 5 shafts. General repair work in the stamp mill and repair of the Isle Royale railroad between mill and mine also are near completion.

▶ Several stopes in the Globe property of the Copper Range company, at Painedale, are now in production. The company's option on the property has been exercized, which adds 2,985 acres of mineral land to Copper Range holdings. Globe adjoins the Champion mine immediately to the south and St. Mary's lands to the north. As the latter are owned by the company, Copper Range now has a continuous stretch of approximately 10 miles of mineral lands south of the Champion. This does not include mineral lands still farther south owned by the company. Drilling at the White Pine property indicates general mineralization of this area. The copper is finely divided and occurs as both native and sulphide. The showing to date is encouraging. Considerable experimental work will be necessary to determine the methods and processes best suited to economic mining, concentration, and smelting. Copper Range is successfully reclaiming copper from amygdaloid sands or tailings. Extraction has been materially improved after experimentation and a recovery of 4 lb. per ton at a cost of 35c. is the result. The sands can be treated at a profit when the price of copper is 10c. or more. The old sands at the Champion mill are being constantly washed away, and if they are to be recovered for re-treatment it must be done while they are still there and when the price of copper permits profitable operations.

▶ Calumet & Hecla Consolidated Copper Company recently announced a curtailment in production. "During the past eight months the company has sold what it could ordinarily produce in twenty working days. This naturally has resulted in an accumulation of copper on hand. Because of the lack of demand for copper and the general uncertainties of the future, it has therefore become necessary to restrict production for the time being." Output will be reduced about 30 per cent.

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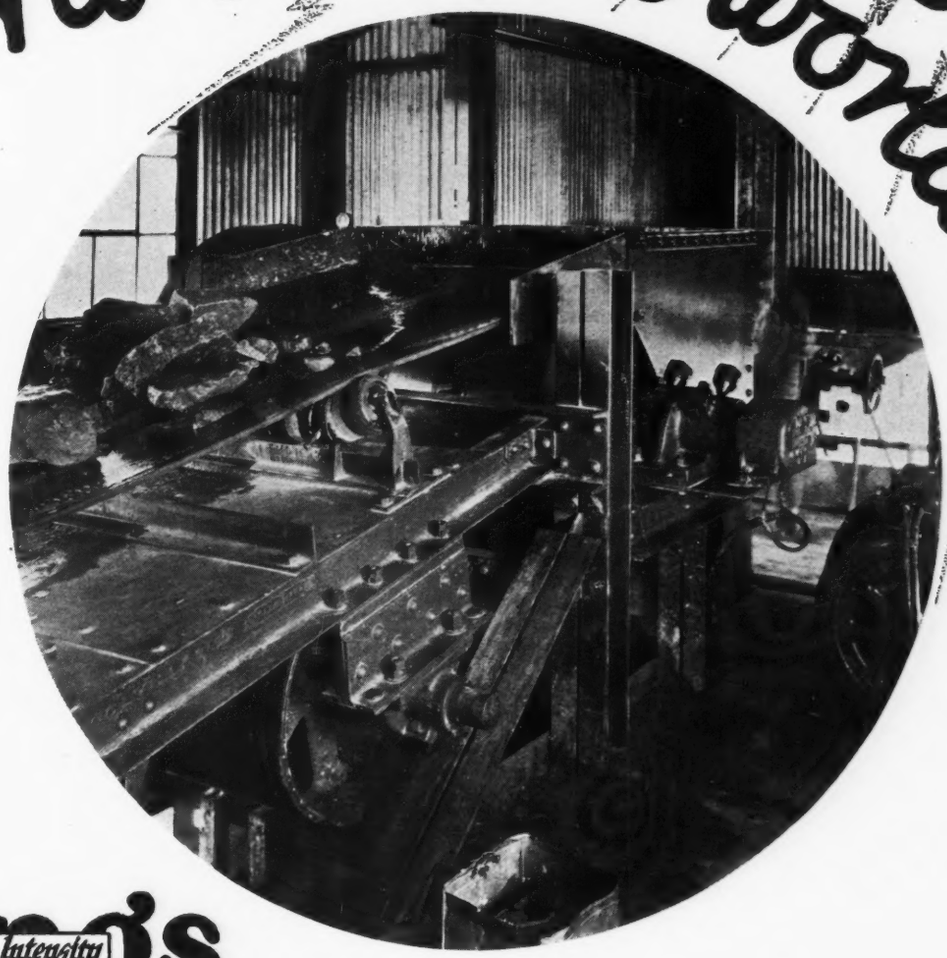

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NEWS FROM Washington

By Special Correspondent

INTERNATIONAL affairs are no less important now than a month ago, but the tension and threat of war is markedly less. The British-Italian agreement on Mediterranean affairs was the greatest relief valve that has operated. Continued release of Nazi enthusiasm eastward, *without fighting*, is a minor stress-relieving development. And the sharp defeats suffered by Japan in China make world embroilment less likely.

Washington expects that the big Navy program will be a major element of American cooperation with Britain. And the British trade agreement which may be signed early in June will be notice to the world that the English-speaking nations intend to do business together on a cooperative plan with enlarged activity. But none of these peace-making factors is in any way reducing the interest of officials in a better mineral reserve and a more adequate preparation for strategic metal supply. Furthermore, the big-ship, big-gun policy means more demand for the high-value products of mining and metallurgy.

Mineral Independence

NO ONE has more important influence on international mineral affairs than Secretary of State Hull. It is of particular importance, therefore, to study his communication of early April to Senator David I. Walsh, as he comments on the problem of national defense with respect to necessary raw materials. The pertinent part of that communication is:

"An independent study of the sources of supply of strategic raw materials was prepared by Brooks Emeny and published by MacMillan in 1934, under the Title 'The Strategy of Raw Materials'. Mr. Emeny points out that the principal raw materials of importance in a wartime economy which are normally secured principally from sources outside of this hemisphere are the following: rubber, which is secured principally from British Malaya and the Netherlands East Indies; tin, the principal source of which is British Malaya, with secondary sources of supply in the Netherlands East Indies and Bolivia; chromite, principally from Rhodesia; tungsten and antimony, both principally from China; manganese, of which Soviet Russia is the first supplier with Brazil and British India important sources.

"In his study of strategic problems connected with each of these materials, however, Mr. Emeny comes to the conclusion that adequate supplies, for at least a two-year wartime emergency, could be secured from domestic producers and other sources in the Western Hemisphere in the case of manganese, antimony, tungsten, and chromite, although the interruption of imports from the principal suppliers in normal times might cause considerable difficulty in maintaining the most efficient industrial production in this country, requiring conservation of materials, the use of substitutes, and recovery of secondary materials to as great an extent as possible.

"In the case of tin, domestic sources are of practically no importance and the probable maximum production of Bolivia would supply only about 50 per cent of annual requirements, and even these supplies would not at present be useful unless either they were first shipped to Great Britain for smelting or a tin-smelting industry were created on this continent. The necessity of importing tin in time of emergency could be greatly limited, however, through extension of the recovery of tin from secondary sources and the use of substitutes.

"In the case of rubber, again the requirements could be greatly limited by the recovery of secondary rubber, the expansion of production of synthetic rubber, and substitution and conservation. At the present time no important supplies are drawn from this hemisphere, but some plantations are now under development, and, more important, there is a vast supply of wild rubber available in South America if the price of rubber would warrant the necessary expenditure for collecting it.

"Any vital dependence of the United States upon sources of supply of raw materials outside of the Western Hemisphere, which would appear to necessitate the defense of far-flung trade routes, might be removed by the accumulation of stockpiles of these materials in the United States adequate to meet national needs in time of probable emergencies."

TAX RELIEF

TAX REVISION by the House of Representatives went a long way toward giving relief to business from the most objectionable of present Federal tax laws. The Senate went even further, fully eliminating even the vestige of the President's pet scheme for extra taxes on undistributed profits. The President did not like this and said so in an unprecedented manner. He undertook to influence the action of the conference committee considering this tax bill.

THE CONFERENCE compromise left only a face-saving fragment of undistributed profits tax. Yet the psychological outcome of the controversy remains in doubt. There seems to be no question that most of the relief urged by business spokesmen at Congressional hearings has been granted. And yet the total tax collected from business next year may be higher than last. It certainly would be if business had profits as great.

THE MINING INDUSTRY can be gratified that some of its most urgent needs for relief were recognized. The principle of accounting for the value of inventories by the principle of "last in, first out" was accepted by the Senate. Furthermore, no effort was made to amend the present law which grants to mining enterprises their special form of percentage depletion allowances. But the industry was not granted its request for the carrying over of losses for two years, or the relief from profits taxes under special circumstances for sinking funds or where construction work is necessary.

Lend, Spend, Give Away

LAST MONTH it was "Lend or Spend." Now it is lend, spend, and give away. A total between $4,000,000,000 and $5,000,000,000 is involved. The President's recommendations contemplated approximately the following:

Relief via W.P.A.	$2,000,000,000
Public works, via P.W.A.	1,000,000,000
Business loans, via R.F.C.	1,500,000,000
Other items	500,000,000

Of the relief money it is proposed that only seven months' requirements be provided at once by appropriation of $1,250,000,000. But the year's total at this rate will reach the higher figure above named. It is also evident that the P.W.A. money is a top figure, but that not necessarily all of it will be used for grants, loans, or direct Federal construction. No one can guess what share of the R.F.C. loan money will be asked for or granted. The minor items that total a mere half billion will include continuance of C.C.C., Farm Security Administration, National Youth Administration, and renewed effort on highways, flood control, and Federal buildings.

It is expected that Congress will go along on most of this disbursement program, though details are subject to change from week to week as public sentiment and political contingencies change.

Electrolytic Manganese

SPEAKING in justification of requests for appropriations of next year, R. S. Dean, chief of the metallurgical work of the Bureau of Mines, described the present status of his investigations for the production of manganese from Western low-grade ores. The following statements are assembled from that testimony:

"The manganese which is produced by our process, and of which we have produced several hundred pounds—perhaps a thousand altogether—is a different material than has heretofore been available to the industry. It is a much purer material than any that has been heretofore available, and it is therefore of use for purposes for which the material heretofore available from imported ores cannot be used. On the other hand, of course, by the addition of other materials, such as iron and carbon, we can produce a ferromanganese which certainly should be equivalent in every way to a standard ferro.

"We have developed a series of alloys made from this material which we believe have possibilities of being equally satisfactory for corrosion-resisting purposes as monel metal or nickel silver and other alloys which are now used. The alloys are not yet in commercial production.

"The manganese ore is leached with sulphuric acid and electrolyzed, to give pure manganese metal. We have recently made an estimate of cost, or, to be accurate, that estimate of cost has been made by a commercial firm interested in producing the material. It has been a very careful and thorough estimate, which recently came to my attention, and the figure which they obtained, using as the basis for the price of manganese ore, the present current market price for imported ores which are used in ferro, and using a power cost of 2.3 mills, which is a higher cost than we can obtain, I believe, at Boulder or at some of the Western power plants, and making adequate provision for plant depreciation—their figure is 6.7c. per pound. It takes approximately 3 kw.-hr per pound.

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Japan	106,180
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Other patents pending

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. . Minimum initial lip weight—minimum scrap weight on worn lip.

. . Lip flare scientifically designed—no bucket drag—minimum power required.

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Easy Money

GETTING BUSINESS STARTED by making money easily available has become a major effort of the New Deal. One of the most significant actions is that of Securities and Exchange Commission, which by modifying its Rule 210 will permit enterprises to put out issues for not exceeding $100,000 with a minimum of formality. Under the new rule notice of intention to issue the securities must be given to SEC and copies of prospectuses and similar promotion literature must be put on file. It is hoped that this exemption, which is temporary and effective only until Oct. 29 of this year, will stimulate prompt financing for moderate size mining and other enterprise.

The decentralization of gold which will release ultimately $1,400,000,000 from idleness in the Treasury is intended to function as a stimulus on commercial loans by banks. Fewer Government securities will be available to these institutions as roughly $50,000,000 worth of borrowings are retired weekly. Furthermore, new Government purchases will be paid for with currency issued against gold instead of by borrowings. Thus the surplus bank reserves will, Government officials hope, overflow from bank coffers into mining, manufacturing, and marketing loans.

Despite all this stimulus to business by the Government, the burden of taxes grows. Recent estimates are that tax collectors took 60c. out of each corporation dollar of earning, whereas only 40c. could be distributed as dividends or used for enlargement or betterment of business property. The Administration seems deaf to appeals for relief in this direction.

Fume-Damage Award

BY TREATY, Canada and the United States some time ago agreed that the fume damage from the Trail, British Columbia, smelter occasioned to American forestry and agriculture should be investigated by an international tribunal. That august body has been meeting regularly since the first of the year, and on April 20 released its findings. The technical portion of its award is indicated by decision regarding the three pertinent questions on which the tribunal rules:

> "Whether damage caused by the Trail Smelter in the State of Washington has occurred since the first day of January, 1932, and, if so, what indemnity should be paid therefor?"

"The tribunal found that damage had so occurred and made an award of $78,000 for such damage from Jan. 1, 1932, to Oct. 1, 1937, with respect to damage to cleared land and uncleared land, and uncleared land used for timber. The United States, in addition to the claim for damage to land and timber, asserted damage in respect of livestock, damage in respect of property in the town of Northport, and damages in respect of business enterprises. But the tribunal failed to uphold the contention of the United States that damage had occurred to these properties."

> "In the event of the answer of the first part of the preceding question being in the affirmative, whether the Trail Smelter should be required to refrain from causing damage in the State of Washington in the future, and, if so, to what extent?"

"The tribunal decided that until the date of its final decision the smelter should refrain from causing damage in the State of Washington in the future to the extent set forth in a temporary regime provided for in the decision until Oct. 1, 1940, and thereafter to such an extent as the tribunal should determine."

> "In the light of the answer to the preceding question, what measures or regime, if any, should be adopted or maintained by the Trail Smelter?"

"The tribunal was of the opinion that with the information at hand it was not able to determine upon a permanent regime for the operation of the smelter. However, it did set forth in detail a temporary regime which was to be put into operation by May 1, 1938, to cover the remainder of the crop growing season of 1938, the crop growing seasons of 1939 and 1940, and three months beyond Oct. 1, 1940. This temporary regime is to be under the technical supervision of two experts who will act as consultants to the tribunal and be under its authority. As a part of the regime it is provided that for the entire period until Oct. 1, 1938, the sulphur dioxide recorder which measures the sulphur content of the air shall be continuously operated. When, between the hours of sunrise and sunset, the sulphur dioxide concentration exceeds one part per million for three consecutive twenty-minute periods and the relative humidity is sixty per cent or higher, the smelter shall be immediately notified, and the sulphur emission from the stacks of the plant maintained at five tons of sulphur per hour or less until the sulphur dioxide concentration at the recorder falls to 0.5 parts per million. The regime, however, is intended to be elastic and under the complete control of the tribunal. The expenses for this temporary regime will be undertaken by the Dominion of Canada."

CONGRESS VS. PRESIDENT

THE HEAVYWEIGHT political title is at stake. Titleholder Roosevelt lost two important rounds during April, one to the Senate on tax revision and one in the House on reorganization. But there are numerous rounds to come. Any doubt that next is a battle for political control over the Treasury pursestrings disappeared during April. Business prospects, economic trends, as well as control of the Democratic party in 1940, are at stake. No polite rules of the boxing ring remain. All holds and weapons are permitted.

OCCASIONALLY still there has been effort to make all this controversy look like a difference of opinion as to the proper method of serving the public in escaping from a recurring depression. But more frequently in print, as well as privately about Washington, it has become evident that the real issue is the control of spending for the next two years.

HE WHO HAS that control will influence, if not "purchase," votes. Congress, therefore, has wanted to earmark all of the big new moneys provided for public works. It does not like Presidential decisions to govern these disbursements, lest the President have a vote-influence beyond the resistance of the individual Congressman or Senator. And the public rather soon caught on. If not, it will be informed of these factors as debate progresses through the rest of this session of Congress.

Secondary-Metal Survey

A COMPREHENSIVE inquiry of statistical and economic nature is planned by the Bureau of Mines, to begin July 1. At that date it is expected that there will be available a small additional appropriation from Congress with which the Economics Branch of the Bureau can undertake a continuing study of scrap metal and the production of secondary metals, both ferrous and non-ferrous. This work will be done by a new unit to be established at the Pittsburgh Laboratory, from which headquarters both field studies and statistical inquiry will be directed.

Other appropriations for the Bureau of Mines will permit small increases in the activity of various other divisions of the Bureau, but relatively few new activities. Work of the United States Geological Survey on stream gaging and topographic surveys are the only parts of that bureau's work which are to be materially augmented next year as compared with this. The work of the Bituminous Coal Commission is also to continue along the same lines as last year, with $3,000,000 appropriated, as recommended by the Budget Bureau.

Minor News Notes

Phosphate—The President continues to promise a report of Western phosphate development, but any prospect of legislative action this year has passed.

Helium—Exports of helium have been held up because Secretary Ickes fears military use of supplies wanted for German Zeppelin operation.

Platinum—New commercial standards have been proposed for the marking of articles made wholly or in part of platinum. Interested parties should communicate with the National Bureau of Standards.

Silver Lined Cans—The Bureau of Standards says: "A relatively inexpensive form of solderless, silver-lined container suitable for the shipment and storage of foodstuffs, pharmaceuticals, and chemicals has been developed."

Stream Pollution—Legislation on this subject has remained in conference committee blocked by "irreconcilable differences" between the two houses. Even an attempt by the Public Health officials to reconcile regulatory with investigatory ideals failed utterly. At the beginning of May prospect of enactment seems remote.

Quicksilver—Western purchases of quicksilver, alleged to be for export, have stirred Washington interest, but the rumor is strongly doubted. Some suspect that quicksilver is being bought as a speculation and others claim that new industrial developments in electrochemistry (making chlorine and caustic soda) account for the recent large sales.

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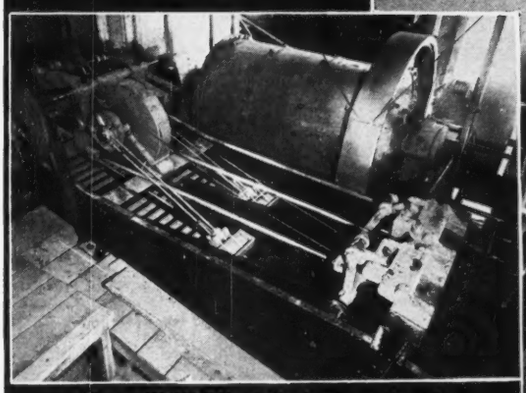

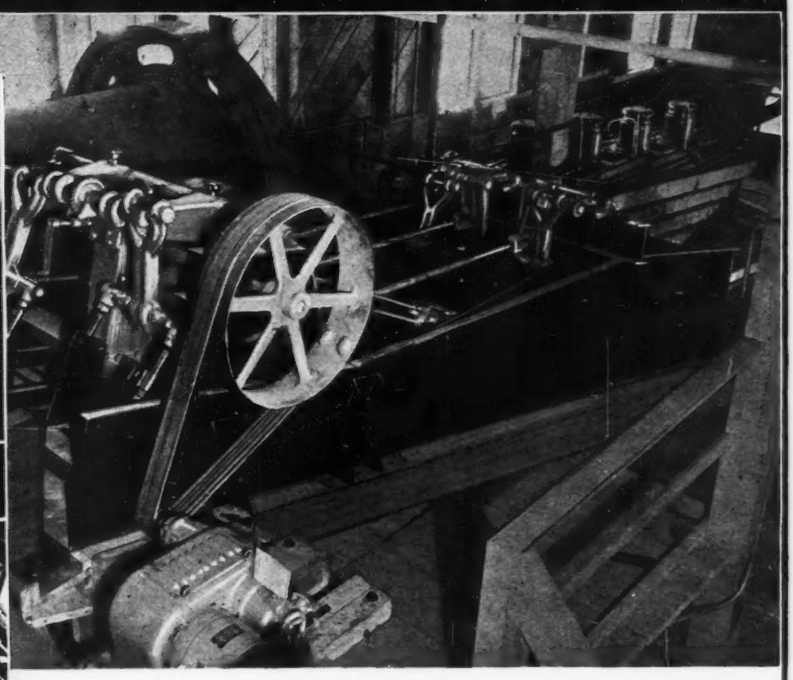

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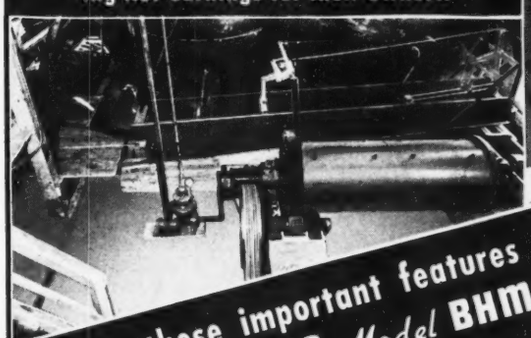

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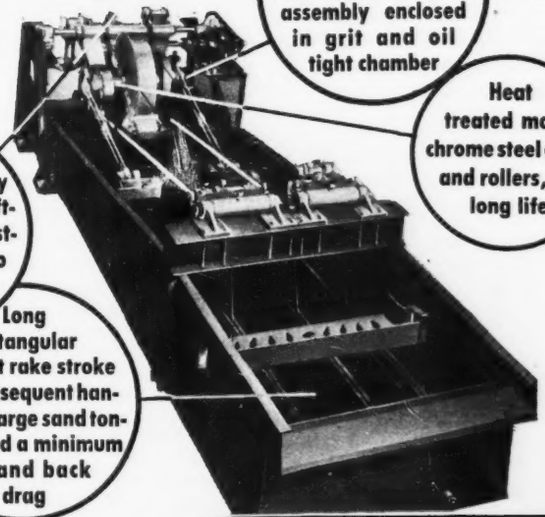

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MONTANA

Eudora Mining Company Plans Development

Adit will be driven to contact ore—Floating dredge will recover gold in Prickly Pear Creek

▶ Preparatory to the installation of a floating dredge, a power shovel has recently begun digging a dredge pond near Alhambra Hot Springs, on Prickly Pear Creek, near Helena. The boat will be a 6-ft., electrically driven, steel-hulled Yuba constructed unit similar to that in service at Helena on Last Chance Gulch, now operated by Porter Bros., but differing in that Pan-American jigs will be installed instead of tables. The plant has been ordered by Winston Bros., with delivery expected within the next few weeks. It is recalled that the Winston Company has been operating on Prickly Pear Creek for a number of years with special equipment consisting of a large dragline shovel feeding a New York Engineering Company floating-type washing plant. Owing to frequent moves over permanent obstacles such as railroad rights-of-way shallow gorges, and highways, this lighter and more mobile equipment was required. Now it appears that a more continuous working acreage permits the more conventional plant installation, and it appears likely that this decision marks the inception of a new major dredging operation in Montana, which will be in operation during the coming summer.

▶ According to current advises, developments at the Revenue Mine, Madison County, have advanced to a point supporting a plan by the management, P. Jackson, president, to finance and construct a concentrating plant to treat the gold-bearing ores now proven. During recent years, the Frisbie lease on the Lexington vein, a part of the Revenue vein system, has been very successful, and it is expected that a substantial part of the expected production will be derived from workings in the Revenue below the Frisbie Lease. Mr. Frank Springer is superintendent in charge of operations.

▶ It is reported that Louis Hoffman, who has a lease on the holdings of the New York Mining Company at Bannock, plans to resume operations at that property immediately. Formerly worked by the I-B Mining Company, the property is fully equipped with a 100-ton electrically driven cyanide plant, and according to reports recent development has provided ore which is broken and available for treatment. In addition to the central operations by Mr. Hoffman, a number of leases on outlying units have been granted which by agreements in force are expected to provide additional feed for the milling operation.

▶ Announcement has been made that an extensive development program is contemplated by the Eudora Mining Company in Flathead County near the Flathead mine of the Anaconda Copper Mining Company. The Eudora property, discovered and pioneered by John Bergman, of Whitefish, resembles the Flathead mine in many respects. J. McCloud has been appointed superintendent. The known silver oreshoot was discovered in a shaft development, but present plans are to drive an adit through Anaconda ground by a free agreement extended by that concern. An ore bin and truck-road access to the adit portal will greatly reduce the production expense against the shipping ores to be mined. Shipment to the Washoe smelter of the Anaconda Copper Mining Company requires first a 19-mile truck haul and then a long freight haul.

▶ It is reported that a novel plan of shaft sinking is in progress at the Jay Gould mine of the Standard-Silver Lead Company, of Spokane. Heavy water flow is encountered in sublevel developments, and to facilitate water handling in sinking, two 10-in. holes will be piloted ahead of actual sinking for the purpose of draining the shaft area. One hole, outside the area will serve as a water sump through its connection at the bottom by "springing," and thereby drainage will be effected from the shaft-sinking operation.

UTAH

Bog Mining Company Resumes Operations

Silver-lead producer also plans extension of two tunnels—Base-metal production continues on a reduced basis—Silver King Coalition Mines suspends production

▶ On May 1, the Bog Mining Company resumed operations. At this property, the company installed power-drilling equipment last fall and built a new camp after completing two miles of heavy road construction. This summer, work will be carried on from two points in the property—the upper Bog tunnel and the lower Bog tunnel, 400 ft. vertically below and about 1,000 ft. to the southeast. General Manager M. A. Bourne of Provo, Utah, recently announced that a compressor plant would be installed at the lower tunnel. This adit will be driven an additional 400 ft. to get below the showing of silver-lead ore opened in the upper tunnel last fall. This ore, followed for a distance of 120 ft., carries values ranging from $2.10 to $4.20 in gold; from 17 to 70 oz. of silver; 6 per cent lead; and from 2.67 to 2.18 per cent copper. The upper tunnel will be extended to reach the main Miller Hill fissure, and this zone followed to its intersection with the Bog, the Dyke, and the Silver Dipper and other fissures. A carload of ore is being produced for shipment to a Utah valley smelter. John Bestlemeyer of Provo, a veteran Tintic mining operator, is superintendent of operations.

▶ Stimulated by the new discovery in the Cardiff mine, prospecting and producing companies in the Alta district, 25 miles southeast of Salt Lake City, are planning an active summer. Snow is melting rapidly in the Little Cottonwood Canyon road, and the West Toledo, Columbus-Rexall, and Alta Merger companies are planning an early resumption of activity.

▶ Silver King Coalition Mines Company ceased production from its mines on May 1, for an indefinite period. The mines are producers of lead, zinc, and silver, but most of the earnings are derived from lead-zinc ores, and low prices for these metals force the company to suspend operations, releasing about 450 men.

▶ On May 5, Park Utah Consolidated Mines suspended operations because of low prices for base metals, thereby throwing 250 men out of work.

▶ Producing mines in Utah continue to operate on a reduced basis of output, hoping for an improvement in the prices of metals, while prospecting companies are planning renewed activity. The hopes of reaching important objectives, added to the fact that roads into mountain camps are beginning to open after the spring break-up, explain stimulated activity on the part of prospects rather than an unusual demand for metals. Operations at leading mines are of routine nature. The International Smelting Company is still pushing ahead its Elton tunnel in the National Mines & Tunnel Company ground at Tooele. Progress has been slowed down by the unfavorable nature of the formation and a substantial flow of water.

▶ Completion of the Utah Copper Company vehicular tunnel has been retarded since the two bores made their connection early this spring, awaiting the arrival of special steel forms. However, now that these are on the ground and installed, pouring of concrete is making orderly progress.

▶ Between 300 and 400 tons of ore daily are being milled at the plant of the Snyder Mines, Inc., at Mercur. Stripping operations are being carried on at two places in the Consolidated Mercur group, about 1,500 ft. apart, and ore is being taken from surface pits and conveyed by truck to the mill. Grade of the ore ranges from 0.08 to 0.15 oz. gold to the ton.

▶ The first of May saw work well under way at producing mines and prospects in the American Fork district. Leasers, under the direction of N. C. Nielsen, have opened a body of ore in the old Pacific mine, netting about $42 a ton. With the reopening of the road into the historic district, shipments will be made from this property and the American Smelting and Refining group in Mary Ellen Gulch, where Willard Cleghorn and associates are operating leases.

▶ Net earnings of the Park Utah Consolidated Mines after depreciation for the year 1937 amounted to $269,059.07, according to the annual report of General Manager O. N. Friendly, Continental Bank Building, Salt Lake City. Current assets amounted to $992,571, an increase of $27,474.12. Production was confined mainly to the Judge or west unit of the Park City property. Ore sales amounted to $1,274,244.95 in payment for 93,014 tons of ore, having a metal content of 25,124,359 lb. of zinc, 19,005,938 lb. of lead, 559,508 oz. of silver, and 2,414 oz. of gold.

American Zinc Institute Convenes In St. Louis

Problems of the industry discussed and outlook depends on spending by farmers and new construction

MEMBERS of the American Zinc Institute met in St. Louis at the Hotel Statler on April 25 and 26, and coincident with the occasion the galvanizers' committee, sponsored by the Institute, joined in the meeting that marked the twentieth birthday of the Institute.

Presiding at the first session, Monday, President Howard I. Young introduced W. L. Hemingway, chairman of the board of St. Louis Chamber of Commerce, who gave the address of welcome. In response Charles T. Orr, first president of the Institute, described how the organization came into being twenty years ago. Secretary E. V. Gent in his report told members of the work done in presenting briefs requesting no change in existing tariffs on zinc and zinc products now under consideration in reciprocal trade agreements with Canada and the United Kingdom. Mr. Gent expressed a desire on the part of the Institute to develop closer cooperation with steel-company sales and promotion departments in the campaign for greater use of galvanized sheets bearing the "Seal of Quality" mark.

Political and economic events and their influence on the zinc industry were discussed by Julian D. Conover, secretary of the American Mining Congress. He pointed out that studies of economic cycles show that there have been fourteen business recessions since 1890, with an average length of seventeen months, and that ten of these lasted for fourteen months or less, and only four exceeded fourteen months. "From the high point from which the present recession of industrial activity started in December, 1936, the decline is now in its sixteenth month. Eminent opinion, however, holds that we have already traversed the ground that should be necessary to eliminate ordinary economic maladjustments and to start things up once more, but a large mass of opinion from sound, hard-headed business men and economists whose views command respect relates our present troubles directly to the actions and policies of our national government which are frightening or stifling ordinary business initiative and holding back the natural forces of recovery."

Referring to the reciprocal trade agreements Mr. Conover said: "The most important Washington developments in recent months have been the negotiations with Great Britain and Canada for reciprocal trade agreement. . . . There has been the finest cooperation on the part of all these concerned with the welfare of these great industries in making clear the need for continuance of the existing protection and these protests have been sympathetically received."

At the afternoon session, John A. Robinson, vice-president of Commerce Mining & Royalty Company, presided. A paper, "The Situation in Zinc," by W. R. Ingalls, director of the American Bureau of Metal Statistics, was read by R. B. Caples, assistant general superintendent of the Anaconda Copper Mining Company reduction department. Mr. Ingalls thus sums up the future for zinc:

"The domestic outlook for zinc in 1938 is closely interwoven with our broad economic prospect, including the building of houses and other edifices, the manufacture of automobiles, the fencing by farmers, etc. At the present time all of those channels of consumption are running pretty dry. I wish I knew when the flow through them is going to swell. We have experienced a serious dislocation in affairs, from which readjustment will require patience, even after we are convinced that the tide of our present recession has turned." C. S. J. Trench, president of C. S. Trench & Company, discussed the general conditions in the zinc market.

Meetings on Tuesday were joint sessions of the Institute and the Galvanizers' Committee, presided over by R. T. Orr, vice-president of Athletic Mining & Smelting Company, and Nelson E. Cook, general superintendent of galvanizing of Wheeling Steel Corporation. Papers presented were: "The Meaker Process of Electro-galvanizing," by Ernst H. Lyons, Jr., chemist of the Meaker Company; "Galvanizing Problems From the Zinc Metallurgist's Viewpoint," discussed by W. M. Peirce, chief of research, The New Jersey Zinc Company; "The Field for Cooperative Promotion," by K. L. T. Ekblaw. Dr. John W. Finch presented his paper "Strategic Minerals in the United States" and pointed out that aluminum, antimony, chromium, manganese, mica, nickel, mercury, tin, and tungsten are strategic minerals and that iron and steel, copper, lead, zinc, and petroleum are among those known as critical minerals. The accumulation of these minerals in stockpiles by purchase instead of trying to accumulate them through domestic production was commented upon by Dr. Finch as follows:

"It seems to me that the time has come to face this problem with candor. In my opinion the American public at present is reluctant to extend further the principle of subsidy to industries through increased tariff protection but would probably support overwhelmingly a program for the purchase of stockpiles of strategic minerals for purposes of national defense. This is substantiated by the numerous bills on this subject now pending before Congress and by the fact that last year Congress for the first time accepted the principle of stockpiles by providing the Navy Department with funds to purchase supplies of strategic materials. Under this bill the Navy has been acquiring supplies of tin, chromite, and manganese and purchase of tungsten is contemplated in the near future."

(Continued on page 76)

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(Continued from page 75)

The afternoon session was devoted to problems and progress of the galvanizing industry.

Officers re-elected were Howard I. Young, president; C. Merrill Chapin, Jr., John A. Robinson, and James O. Elton, vice-presidents; James A. Caselton treasurer; and Ernest V. Gent, secretary.

TRI-STATE

Zinc Mills Working on Part-Time Basis

Some tailings re-treatments plants suspend operations—Two mills being dismantled for moving

▶ Production had dropped to less than 6,500 tons of zinc concentrates and 1,200 tons of lead concentrates per week by the end of April, with approximately 40 mills in operation, five of which were tailings re-treatment plants and three treating a mixed feed of mine ore and tailings. The mills closed during the past month included the Vinegar Hill Zinc Company, at Barr; Sunflower Mining Company; Skelton Lead & Zinc Company (mixed feed); Missouri Mining Company at Chitwood; Tri-State Zinc, Inc.; Ottawa; and Sooner, the latter three being tailings re-treatment plants. Approximately one-fourth of the mills were operating part time.

▶ P. E. Tabor, representing St. Louis interests, is dismantling the Leopard mill of the Velie Mines Corporation. The Leopard mill, with a capacity of 50 tons per hour, was one of the largest and most modern mills in the district when it was built in 1927. Much of the building material and equipment will be used in a custom mill to be built on the Napoleon lease northwest of Joplin, according to Tabor.

▶ Fred Childress and associates have subleased from the Eagle-Picher Mining & Smelting Company mining properties in the Neck City, Mo., camp and are making preparations to start mining operations. The ore will be concentrated at the Central mill of the Eagle-Picher Mining & Smelting Company near Commerce, Okla.

▶ The R. H. & G. Mining Company has reconditioned its mill at Waco, Mo., to treat a combination of mine ore and tailings. Several mills in the district have successfully adopted this method, which permits the operation of a mine with small ore reserves.

▶ The Semple Mining Company is dismantling its Rightly tailings re-treatment mill and rebuilding it just southeast of the town of Hockerville, Okla. Tailings from the Aztec, Bluebonnet, and other tailings piles in the vicinity will be re-treated.

▶ The new differential density cone plant at the Central mill of the Eagle-Picher Mining & Smelting Company was completed the middle of April, and test runs have proved very satisfactory. A very satisfactory tailing is being produced on plus one-eighth inch, minus one inch material, and the enriched product is sent to the regular concentrating sections of the mill. If economic conditions justify, the mill will be stepped up from 6,000 to 10,000 tons per 24 hours after the completion of the test runs on the cone section.

Sunnyside section of Kellogg, in the heart of the Coeur d'Alene mining district, where the Coeur d'Alene River broke through dikes late in April. Mines suffered losses due to tie-up of automobile and railway traffic for over a week.

IDAHO

Heavy Rains Hinder Mining Operations

Tracks and highways washed out, holding up shipments of concentrates and supplies—Minne Moore to resume prospecting

▶ The Coeur d'Alene mining district suffered a heavy loss during the week of April 18 to 22, when the flood waters of the Coeur d'Alene River, Placer Creek, Big Creek, and many other streams poured over their banks, wrecking highways, homes, and railroads, and demoralizing traffic in general. Damage was estimated in excess of $500,000. Mining operations were greatly interfered with, due to the washed-out tracks of the Union Pacific and Northern Pacific railroads. The Hecla mine suspended work when the rails went out, as did the Morning and Page mines of the Federal company. Bunker Hill & Sullivan continued work, although the dry house at the Reid tunnel was undermined by flood waters. The flood took out a part of an air line and flooded the mill of the Idaho Mother Lode Gold Mines Company at Murray to a depth of 3 ft. All work was suspended pending replacement of damages. The flood came after 24 hours of continuous rainfall, accompanied by a chinook wind. Melting snow in the high hills caused streams to rise rapidly. The snow was 100 in. deep on the Idaho-Montana Lookout Pass and 121 in. on the Burke summit.

▶ The Minnie Moore mine, in the Wood River district of south Idaho, will again be the scene of activity, according to President C. O. Dunlop, who states prospecting for a lost segment of the silver vein will soon be resumed.

▶ Jack Waite Mining Company has re-elected J. F. Duthie as president; G. W. Klinefelter, secretary; and F. W. Holzheimer, Robert Terbune, and E. C. Gaumitz, directors. All are Seattle residents. The property mined 16,234 tons of ore in the first three months of 1938.

▶ Electric power and machine drills will be installed at the property of the Nine Mile Mining Company, Wallace, according to Sam Linn, of Wallace, president. Development will be carried on in the Humming Bird tunnel on a fissure vein.

▶ Sunshine Mining Company has re-elected all of its former officers and directors, with R. M. Hardy, president; Alex Miller, vice-president; C. M. Hull, secretary, all residing at Yakima, Wash.; Joshua Green, of Seattle, and J. B. Cox, of Spokane. R. D. Leisk was continued as general manager. Important developments are reported from the newly discovered orebody on the 1,900 level to the east. The ore is of high-grade silver content. A winze from the 1,900 level will be sunk to the 3,100-ft. mark during the year.

▶ The Rex-Delaware property, formerly an important producer of lead-zinc ore in the Nine Mile district, will soon be in operation again. Title is held by the Callahan Mining Company, of which Donald A. Callahan, of Wallace, is president.

▶ Clayton Silver Mines reported an important ore strike at its property in Central Idaho, according to H. C. Kingsbury, of Wallace, president. Manager C. A. Fay reported the ore about 25 ft. in width, with a full face containing 14 per cent lead and 70 oz. silver to the ton for 40 ft.

▶ The King Solomon mine, in the Fourth of July Canyon district, was the scene of an ore strike early in April, according to

Jean Peters, manager, of Osburn, Idaho. The ledge is 5 ft. wide, with values in lead, silver, and gold. Drifting on the vein has started.

▶ A centrifugal pump weighing 500 lb. dropped 4,000 ft. from a plane and landed safely on the Thunder Mountain Mining Company ground in central Idaho, according to A. H. Sperry, president. The pump was pushed out the plane's door on rollers. Two 24-ft. parachutes opened, and the load was floated to the ground. Nothing broke, but the equipment landed with such force it skidded 150 ft. under 10 ft. of snow. The plane supplies the mine every two weeks.

▶ During the past year the Bunker Hill & Sullivan mine at Kellogg produced 386,576 tons of ore, the largest tonnage since 1933, according to official report of Stanly E. Easton, of Kellogg, president. President Easton stated the mine had 2,670,858 tons of ore developed and exposed for mining. Good ore has been found on the No. 22 level, deepest in the mine.

▶ Installation of the 200-ton concentrating plant at the property of the Gibbonsville Mining & Exploration Company, near Gibbonsville, Idaho, is progressing rapidly, Philo Seelye, of Kellogg, president-manager reported. The mill is the largest in Lemhi County and later will be stepped up to handle 500 tons daily. Ore is now available for several years' steady operation.

▶ The McKinley gold mine, in the Lucile district, will resume operations this summer, according to Harry Adams, of Spokane. The property is equipped with a stamp mill.

▶ Sunrise Mines Company, Sunset Peak area, will soon resume development work, according to C. Fred Kratzer, of Wallace, managing director. A good ore showing was made in former work.

▶ Operations at the Independence Lead Mines Company's property near Mullan will be carried forward with an extensive diamond-drilling program.

▶ Golconda Lead Mines has elected A. H. Featherstone as president-manager; Frank Pearce, vice-president; Herman Marquardt, secretary-treasurer; R. E. Nelson, Ross Roundy, W. H. North, and F. C. Keane, directors, all of Wallace.

ASSESSMENT WORK

(A Correction)

IN OUR EDITORIAL last month urging the completion of assessment work without expectation of further exemption by Congress, we stated erroneously that, "As the matter now stands, claim holders are exempt from assessment work until June 30, 1938." The date should have been June 30, 1937. Work for the fiscal year ending June 30, 1938, must be done unless Congress grants exemption before that date.

IRON COUNTRY

Dull Season in Prospect For Most Districts

Low activity in steel industry forces some iron-ore producers to suspend operations

▶ Conditions on the Mesabi iron range have not changed materially during the last month, as wage rates of labor are still in effect as instituted during the 1937 season, with $5.00 per day of eight hours being maintained as a minimum. The event in the labor union activities was the presenting of a C.I.O. contract to Butler Brothers when the old contract expired. Demands in this contract, it is understood, are quite stringent and they practically dictate policies in all phases of mining, including the seniority rights and check-off system. It is understood that practically no consideration has been given new proposed C.I.O. contracts and some in the industry doubt if anything conclusive will be done this season.

▶ Furnaces consumed 1,776,585 tons of iron ore in February, compared with 4,443,306 tons in February last year.

▶ On March 1, 1938, 37,158,401 tons of iron ore were on hand at furnaces and Lake Erie docks. Analyzing the situation one can readily understand why the iron-ore business is practically at a standstill and all operators are doubtful as to the future schedules. General opinion believes little will be done until the middle of the summer.

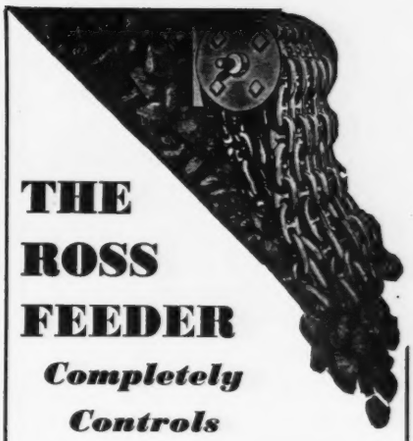
▶ The Republic Steel Corporation is loading stockpile ore at the Alexandria mine, Chisholm, Minn., and at the Julia mine, at Virginia, in the same State. In this connection, the Republic Steel Corporation will close the Alexandria underground mine and also the Julia underground mine, located as mentioned above. It is generally known that the Alexandria deposit is almost exhausted and the business recession has probably spurred the decision to shut down. The Jula mine was a small operation.

▶ Oliver Iron Mining Company will probably ship from various towns along the Mesabi range in an endeavor to take care of labor at least three days a week, and this is true of all the independent mining companies.

▶ The Hill Annex mine, at Calumet, Minn., and operated by the Inter-State Iron Company, a subsidiary of the Jones & Laughlin Steel Corporation, is doing a little stripping, and it is expected that this mine will operate on a curtailed basis this season.

▶ The Arcturus mine of the Oliver Iron Mining Company, at Marble, Minn., has been stripping during the winter months, but this operation is now ended and it is expected that no ore shipments will be made from this property.

▶ The Wisconsin Steel Company, mining department of the International Harvester Company, has cancelled the lease on the Bruce mine, at Chisholm, Minn.



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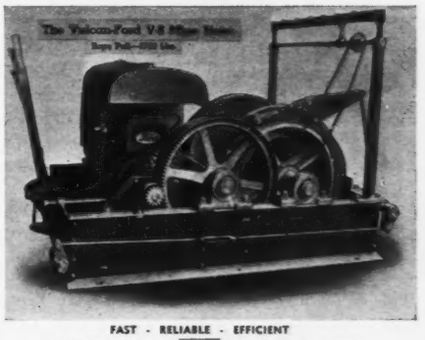

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CANADA

Ore Zone in Malartic Area Shows Extension

Three companies may have combined annual gold output of $3,000,000—Zeballos area, in British Columbia, scene of considerable activety

▶ The most active mining development in eastern Canada at present is taking place in the Malartic area, where the East Malartic, Sladen, and Canadian Malartic mines will have a combined daily capacity for milling more than 2,000 tons of ore before the end of this year. With the installation of new equipment, estimated annual gold recovery from these three producers will exceed $3,000,000. Recent ore developments on the property of Rand Malartic Mines, adjoining east of East Malartic, indicate a substantial extension of the main ore zone of the district. In drill hole No. 39 ore averaging $7.51 was intersected for a total width of 47.5 ft., after eliminating a foot of core that carried much visible gold. This hole is about 1,350 ft. from the East Malartic boundary and adds to the evidence from other diamond drilling which has indicated a large oreshoot of good grade. On the strength of these results it is planned to start shaft sinking in the near future.

▶ Hudson Bay Mining & Smelting Company, operating at Flin Flon, Manitoba, reports a sharp increase in metal sales for 1937, with total income for the year at $17,185,834. The company disbursed $4,826,402 in dividends and added $2,664,258 to surplus and working capital jumped almost 50 per cent, to $9,389,220. R. H. Channing, president of Hudson Bay, reports total assets at $39,237,433. Since 1930, when production was started, most of the ore has come from open-pit mining. Excavation has reached a depth which makes underground methods more profitable, with the result that only 19 per cent came from open cutting in 1937, and next year the supply is to be exhausted. The No. 3 and Main shafts have reached the 2,210-ft. horizon, and ore pockets are being established below that level. Stope development has been completed in some sections between the 1,170 and 1,690 levels. Deeper mining has indicated an increase in ore values, which last year averaged 2.17 per cent copper, 4.7 per cent zinc, 1.52 oz. silver, and 0.107 oz. gold. The sales value of metals produced in 1937 averaged $10.19 per ton, compared with $6.95 in the previous year. The corporation has recently expanded activities through the subsidiary Hudson Bay Exploration & Development Company.

▶ After a five-year shutdown, Sherritt-Gordon Mines started production last August, and in the period to Dec. 31 recovered metals having a total value of $271,454. A net loss of $80,549 is reported by the president, Halstead Lindsley. Ore reserves are estimated by the general manager, Eldon L. Brown, at 3,755,000 tons plus 910,000 tons of low-grade material. Net costs for producing electrolytic copper in 1937 amounted to 7.097c. a pound, compared with 6.195c. in 1932.

▶ A special meeting of the shareholders of J-M Consolidated Mines gave approval to plans for reducing issued capital from three and a half million shares to two million; then increasing authorized capitalization to three million, the exchange of stock to be on a basis of four new shares for each seven held. The meeting was told by John W. Shaw, consulting engineer, that satisfactory conditions were being found in the new north shaft workings. North of the shaft on the first level one stope has been opened for a 100-ft. length; the south drift on the same level opened up 135 ft. of ore, including 50 ft. that grades $17.50 across 5.5 ft. The second level north drift shows 175 ft. averaging $10.29 over a width of 4.5 ft. No. 2 shear zone south of the shaft on the 250 level has ore slightly lower in grade for a length of 22 ft. Results on the 375 level are not reported. The 100-ton mill operated for nineteen months until it was closed down in March to allow intensive underground development. Electrical power from the Ear Falls plant near Red Lake, Ontario, is expected to be available at the mine this year, and will mean a considerable saving in cost.

▶ James Houston, mine manager of Gunnar Gold Mines, Manitoba, reports that a crosscut is being driven on the 750 level to intersect the downward extension of No. 3 vein, which has been located by diamond drilling to a depth of 1,000 ft. On the 1,000-ft. level a new vein, No. 6, has been discovered approximately 200 ft. south of the No. 1 vein. No. 7 vein has been located to the north of No. 1 by drilling on the 750 level, and an oreshoot has been opened up for a length of 140 ft. In the anual report of the president, Gilbert A. Labine, it is stated that encouraging results on the 1,000-ft. level led to a deep development program which is opening up two new levels down to 1,250 ft. Positive and indicated ore reserves at the end of 1937 amounted to 97,072 tons. The mill has a daily capacity of 150 tons and has been operating efficiently since April, 1936.

▶ God's Lake Gold Mines, in northeastern Manitoba, reports the most successful year in the company's history. The president, R. J. Jowsey, emphasises the importance of an increase in the value of ore reserves amounting to $1.05 per ton, with a grade of 0.3 oz. In the past year the mill treated 61,477 tons of ore and 15,900 tons were added to reserves, which stood at 152,400 at the year-end. Although gold recovery per ton was lower than in 1936, better results are expected for the present year. Gold recovery last year averaged 92.6 per cent. Operating costs have been reduced 36c. a ton, to $7.06.

▶ According to an announcement by John Knox, manager of Francoeur Gold Mines, Rouyn district, Quebec, ore reserves are estimated at 151,400 tons, having an averaged gold content of $9.08 per ton. Allowing for dilution of 20 per cent, reserves would be raised to 182,000 tons and the grade lowered to $7.25 per ton. Combined mining and milling costs are estimated at $4.50 for the first year of mill operation. Construction of a 150-ton mill is to be started soon, making use of flotation and amalgamation, the concentrates to be shipped to the Noranda smelter. A 325-ft. shaft is sunk on a 45-deg. incline, with levels established at 190 and 315 ft. More than 2,300 ft. of drifting has been completed on these two levels.

▶ Normetal Mining Corporation, operating a complex gold-silver-lead-zinc orebody in northwestern Quebec, reports an operating loss of $56,286 for the first period of production, Sept. 18 to Dec. 31, 1937. The mill treated 20,843 tons to the year-end and stockpiled the concentrates to await the opening of navigation on the St. Lawrence River. In the early stages metallurgical troubles were experienced which are now taken care of, and it is expected that by next month the mill will be operating at 500 tons daily. Normetal is a subsidiary of Mining Corporation of Canada. R. Basserman is mine manager.

▶ Arntfield Gold Mines, adjoining Francoeur on the east, reports a new peak production since December, 1935, for last March. Gross recovery is $33,000 from an ore grade of $4.23 per ton. Output per quarter for the remainder of this year is expected to be around $100,000, according to the resident manager, V. A. James. The daily mill rate is 250 tons, with operating costs below $4.00 per ton. Development work is proceeding on the 250, 625, and 975 levels. Current ore reserves are estimated at 140,000 tons valued at $5.00 per ton.

British Columbia

▶ The favorable zone in the Zeballos area has been solidly staked for a distance of from 15 to 20 miles and this spring prospecting has spread to other mineralized areas along the west coast of Vancouver Island. The settlement at Zeballos is growing rapidly, and is now served by telephone communication and daily plane connection with Vancouver, distant only two hours by air. A 50-ton mill and other buildings are being constructed by Spud Valley Gold Mines, 6 miles from the townsite. At the Central Zeballos ore has been opened in the prospect tunnel for 166 ft. to date, averaging 0.58 oz. gold across a width of 2.6 ft. Diesel power machinery is being installed and it is planned to start a second level at once. The main vein at the Man-o-War, which is thought to be the continuation of the famous Privateer vein, has been cut at No. 2 level, some 200 ft. below No. 1, and it is understood values are better than at the upper level, where they averaged $40 per ton.

▶ Japanese interests, through Sidney Inlet Mining Company, Ltd., are proceeding with the development of the old Tidewater copper mine, on the west coast of Vancouver Island, and it is expected milling will commence in June

at the rate of 150 tons a day. The concentrate will be shipped direct to Japan. Thirty men are now engaged in mining and construction work. Toru Matsubara is the director in charge of operations.

▶ As a result of the exceptionally high prices received for lead and zinc, operations of the Consolidated Mining & Smelting Company of Canada, Ltd., reached a peak in 1937, when sales amounted to $40,483,828 and net profit was $14,669,663. In the 32d annual report, issued by the president, J. J. Warren, it is stated that 2,267,170 short tons of ore was mined last year from the Sullivan mine, at Kimberley, and the following products were recovered in the refineries and chemical plants at Tadanac and Warfield: lead, 206,579 tons; zinc, 142,650 tons; silver, 9,846,545 oz.; gold, 52,435 oz.; copper, 2,292 tons; cadmium, 218 tons; fertilizer, 102,053 tons; and sulphur, 13,533 tons. Antimony will be produced for the first time this year, and it is probable that magnesium will be the next metal product. Despite the increased rate of output, costs were slightly higher in nearly all departments because of metal bonuses paid employees. Average payroll last year was 6,926 men, and wages amounted to $11,600,000. Value of materials purchased was $9,725,000, and taxes were $3,980,000.

▶ A splendid record was made in 1937 by Bralorne Mines, leading gold producer of the Province. Revenue from production was $2,894,209, and net profit was $1,236,751, of which $997,600 was distributed as dividends, equivalent to 80c. a share. Millfeed amounted to 170,683 tons, averaging 0.516 oz. gold. Ore reserves at the end of 1937 were estimated by the managing director, R. Bosustow, at 520,179 tons, of an average grade of 0.5 oz. gold, which is an increase of 15,179 tons and 0.05 oz. gold per ton over the 1936 estimate. Diamond drilling indicates several additional years' supply of ore from the 10th to the 14th level, and it is considered likely by Mr. Bosustow and Ira B. Joralemon, consulting engineer, that it will continue far below the 1,400 level.

▶ Despite the low price of copper, a small profit is being earned by Granby Consolidated M. S. & P. Company. This has been made possible by the reduction of costs from 11.18c. a pound in the third quarter of 1937 to 8.06c. in the final quarter and less in 1938 to date. From the middle of June, when production from the Copper Mountain mine was resumed after an idleness of six years, to the end of the year, 10,451,364 lb. of copper was produced, of a value of $1,074,228. The operating profit was $90,747, and net loss, after all deductions, was $63,019. Normal production of 3,000 tons a day was not reached until about Oct. 1, and in the succeeding quarter 5,940,650 lb. of copper was produced, and an operating profit of $99,437 earned. Net profit was $18,814. A. S. Baillie, general manager, reports that ore reserves were increased last year by 1,257,753 tons, to 10,680,000 tons, averaging 1.45 per cent copper, including dilution by low-grade ore.

▶ Bullion sales of Cariboo Gold Quartz Mining Company in the year ended Jan. 31, 1938, amounted to $1,068,835, and net profit was $541,723. Ore milled was 70,793 tons, of an average grade of 0.4518 oz. gold. Reserves are estimated by the managing director, R. R. Rose, at 246,236 tons, averaging 0.457 oz. gold, the net increase during the year being 36,600 tons. The milling rate was increased from 200 to 275 tons a day, and a further advance to 300 tons will probably be made this autumn. Lateral development is proceeding rapidly in several sections, including the Pinkerton zone, which has not been previously explored to any extent. In the Rainbow fault zone, where more than half the reserves are located, crosscutting has been started from No. 2 internal shaft at the 1,800 and 1,900 levels, and two veins have been cut at the 1,900 level. High-grade ore of narrow width is being developed in the Sanders zone at the 900 level.

▶ A large surface cave-in occurred at the Melvin mine of Consolidated Gold Alluvials at Wingdam on March 22, flooding the workings and almost trapping the mine crew. Production has been resumed from the Sanderson intermediate workings, but it will be from four to six months before operations will be again possible in the Melvin mine. Meanwhile, negotiations are being continued for the advance of further funds by London principals. The ancient gutter of Lightning Creek was entered from the Melvin workings only recently after two years of preliminary work. A. M. Richmond, general manager, estimates that in the areas opened from Nos. 1, 3 and 4 Downstream Raises, there are possible gravel reserves of 16,675 cu.yd., containing between $450,000 and $550,000 in gold. He estimates the total cost of handling these at $250,000.

▶ Silbak-Premier Mines earned $1,001,856 from production in 1937, of which $391,259 was operating profit. After write-offs and other deductions, however, there was a net loss of $312,190. B. F. Smith, manager, reports that the orebodies found in recent years are smaller and more widely separated than those mined in the old Premier workings and the mineralization is less consistent. Ore reserves, however, have increased.

Strides in German Aluminum Production

▶ The aluminum production of Germany is stated to have been just under 130,000 metric tons in 1937, this comparing with 97,400 tons in 1936 and less than 19,000 tons in 1933. Vereinigte Aluminiumwerke, of Lautawerk, German's largest plant, produced 90,000 tons last year, and increased its dividend from 6 per cent to 7 per cent.

▶ Trepca Mines treated 54,965 metric tons of ore in March, recovering 6,214 tons of 78.65 per cent lead concentrates averaging 28.5 oz. of silver per ton, and 6,147 tons of 48.98 per cent zinc concentrates.

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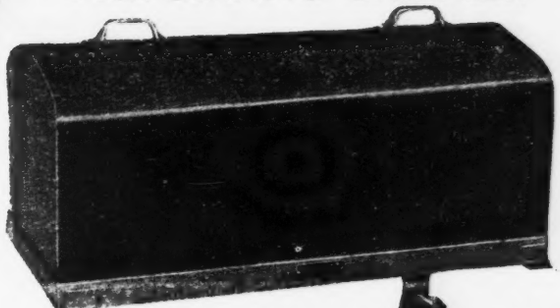

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MEXICO

Mexican Silver Bought By U. S. in Open Market

Cardenas Government has position similar to other open-market sellers of silver—Miners cooperative exploiting Dos Estrellas property is optimistic about production possibilities of old mine

▶ Resumption by the American Government of purchases of Mexican silver, though only on a spot and New York daily price basis, has had a highly favorable reaction. Discontinuance of the agreement to purchase 5,000,000 oz. of Mexican silver monthly from the Mexican Government does not mean that the Treasury has ceased buying metal originating in that country and offered in the open market, Secretary Morgenthau disclosed at a press conference in Washington on April 14. The Secretary of the Treasury was asked whether the termination of the agreement entailed the refusal by the Treasury to buy silver of Mexican origin. Answering this question, Mr. Morgenthau said:

"We buy all spot silver offered to us at the Treasury's price, and so far as I know we will continue to buy all spot silver that is offered."

Asked if the Treasury made inquiry as to the source of the silver it purchased in the New York market at its price (now 43c. per ounce), the Secretary replied that "We do not know where the silver comes from and we don't care."

Under the arrangement now in force the Mexican Government is placed in the same position as other sellers of silver in the open market. The Secretary said he had no records showing how much silver bought by the Treasury since April 1 was of Mexican origin. Mexican producers have been released temporarily from the agreement to sell their silver output through the Bank of Mexico, it was announced in Mexico City on April 14.

▶ Government operation of the oil business in Mexico continues to be closely watched by the mining industry, though President Lazaro Cardenas' declaration that expropriation will not be extended to other industries did inspire confidence. Settlement by A. S. & R. of troubles that hampered operations at its Monterey, Nuevo Leon, Parral, Chihuahua, and San Pedro, San Luis Potosi units, and appeals to patriotism against strikes made by the Federal Government, which is consolidating the public for its program in connection with the oil undertaking, have tended to reduce work difficulties, though these still exist.

▶ Cia. Minera de San Carlos, S.A., El Chapo, Chihuahua, H. H. Horton, Nacozari, Sonora, president and general manager, has put its 300-ton flotation plant into full service after curtailed operations during a period of exploration of the property.

▶ After running Libertad silver mine, near Estacion Diego, Durango, for several years, Tomas Zertuche has turned over the property to his sons Fernando and Jose, who make their headquarters at Juarez, 711, Torreon, Coahuila. They plan expanding operations.

▶ Daily production of nearly 20 tons of silver-lead-zinc ore is being obtained from its mines at Sabinas Hidalgo, Nuevo Leon, by Cia. Minera Soledad, S.A., which is directed by J. O. Villarreal. About 102 men are employed.

▶ Ore produced by La Escondida properties is being handled by Cia. Minera Cerro Prieto, John B. Ford, manager, at its 40-ton flotation mill at Santa Maria del Oro, Durango. Most of this ore is silver.

▶ Personnel of Cia. Minera de Pedregal y Anexas, S.A., near Taxco, Guerrero, H. W. Fowler, general manager, has been increased to 215 men. Jules Lacaud is president of the company, headquarters of which are at V. Carranza, 53, Mexico City.

SCATTERING SPANISH PYRITES

RIO TINTO'S MINES are being worked and are said to be shipping pyrites to 26 different countries, but chiefly to Germany. The company is allowed some sterling for payment of expenses in England, and is using a large proportion of the pesetas received for the balance of its output to pay wages and purchase supplies in Spain.

FRANCO PESETAS are of uncertain value. Some are reported to have changed hands in Paris recently at the rate of 700 to the pound. By reason of its large holdings in Rhokana Corporation, however, Rio Tinto's financial resources are not being depleted.

▶ Thirty men are being worked daily by Cia. Minera El Pinguico, S. A., near Guanajuato City, V. A. Stovall, P. O. Drawer 395, Austin, Tex., president, in developments which include unwatering, placing a hoist, compressor, trackage, and a hauling gas or electric engine; also exploration and work by mining and cut-and-fill methods. Installation of a 25- or 50-ton flotation-amalgamation plant is contemplated. Ramon Flores is directing the work.

▶ Bisbee-Sonora Mining is obtaining about 10 tons daily with a force of nine men from its property at Naco, Sonora. Joseph N. Muheim, Sr., is president, and his son, Joseph, is general manager. Their address is P. O. Box 24, Bisbee, Ariz.

▶ To guarantee payment of workers' claims for extra wages and indemnifications, the machinery of Empresa Minera de El Salto, S. A., Ocampo municipality, Chihuahua, has been embargoed by the Federal labor authorities.

▶ Curious labor trouble has developed for Cia. Minera San Carlos, S.A., Ojinaga, Chihuahua, with the demand that extra workers who were hired for constructions and installations, such as a mill and an electric power plant, be retained on the payroll.

▶ Carlos Hornedo is exploiting the 53 claims that comprise the Wall Street y Anexas properties, gold-silver lands that reportedly have good prospects, near Zacatecas City. Hornedo's address is Hidalgo, 17, Zacatecas City.

▶ Lead-zinc ore mined by Cia. Minera Buenaventura, S.A., Estacion Chilicote, Chihuahua, Federico Prieto, Apartado Postal 9, Chihuahua City, general superintendent, and E. J. Ryan, same address, president, is being handled at the company's flotation plant.

▶ Development costs of Mina Don Felipe y Anexas, owned by Albert Bange, San Juan de Guadalupe, Durango, are being covered by ore that is being extracted. Bange estimates that some 100,000 metric tons of ore are now in sight. Four shafts have been sunk. They range up to about 200 ft. deep.

▶ One of the most currently active mining properties in Mexico is that of Cia. Minera Nacional, S.A., Fresnillo, Zacatecas, S. N. Cook, general manager, who is assisted by R. T. Mishler, J. H. Ashley, mine superintendent, and W. E. Crawford, mill superintendent. The company has now 4,000 employes. Its flotation-cyanidation plant is treating about 3,200 metric tons daily. The flotation plant will soon be able to take on 2,000 metric tons a day. A 300-hr. double-drum hoist is being placed for surface service of a 560-meter level in a new part of the property. Nacional is a subsidiary of the Fresnillo Company.

▶ Contrary to reports, the cooperative society of miners that has been working properties of Cia. Minera Dos Carlos, a British firm, in the Pachuca zone, Hidalgo, since last June, seems to have plenty of money. It has pledged itself to contribute in installments ending Dec. 31, 100,000 pesos (some $25,000) to the Government's fund to indemnify the expropriated oil companies.

▶ The miners recently assured the Finance Ministry that the Dos Estrellas mine can produce one million fine ounces of silver monthly; therefore, this output will be sufficient to enable them to meet all financial obligations. The British firm that formerly operated the mine requested authorities to permit it to cease operations because the mine was well worked out and further operations would be unprofitable.

▶ Cia. Minera Las Animas, S.A., H. L. Givan, president and general manager, who has charge of operations on the ground, is running full blast its 60-ton capacity cyanide plant at Caborca, Sonora. This company, which is installing an electric power plant, pumps, and an Oliver filter, is arranging to resume work at its Juarez mine, which was closed some time ago. The present personnel is 100, of whom about 60 are working in the mines.

▶ Other important work in the Caborca sector includes that by Santa Felicitas Gold Mining, A. M. Conrad, general manager; A. B. Conrad, his assistant; T. S. Lewis, mill superintendent; and Fred Alford, mine superintendent. Sixty men are engaged in mining. Most of the ore is gold. Arrangements are being completed for the placing into service early in June of a 50-ton cyanide plant.

▶ Preparations are being made by the National Railways of Mexico to repair its metal export wharf at Tampico which was destroyed by fire with about 2,000 metric tons of metals, including silver.

AFRICA

New High Copper Output Made By Katanga

Company retires all its bonds and notes —Foundation for Geita mill completed— Tanganyika Minerals, Ltd., starts milling operations

▶ Preliminary report states that Union Minière du Haut-Katanga produced 150,000 metric tons of copper in 1937—a new high record for all time. Profit was Fr. 569,296,309 against Fr. 258,715,741, and the dividend will be the same, Fr. 160 per share on the 1,242,000 shares now outstanding that was paid on the 828,000 outstanding a year ago. The increase of share capital enabled Union Minière to retire all its bonds and notes.

▶ Rhokana Corporation has declared an interim dividend of 25 per cent, the same as a year ago. Despite curtailment of copper output, its low costs and the ability to dispose of its total production of cobalt at the advanced prices are giving Rhokana a fair measure of prosperity.

▶ Roan Antelope Copper Mines has declared a dividend of 6d. per share. This calls for the same total distribution as a year ago, when the interim was 1s. 6d. on one-third the number of shares now outstanding.

▶ The proposal for the capital reconstruction of Tanganyika Concessions by which the capital is reduced from £9,646,620 to £5,445,461 has been made operative by a vote of shareholders. As Tanganyika will receive approximately £200,000 from the Union Minière dividend, it is expected to pay a dividend soon on its preference shares.

▶ Rhodesia Broken Hill Development Company produced 855 tons of slab zinc and 40 tons of fused vanadium in March. Sir Edmund Davis is quoted as estimating this company's production, after plant additions are completed, at 24,000 tons of electrolytic zinc, 70,000 tons of lead concentrates, and 700 tons of vanadic oxide annually.

▶ Kentan Gold Areas reports that 80 to 85 per cent of the materials for the mill and power plant at the Geita Gold Mining Company, Tanganyika Territory south of Lake Victoria, has been purchased and is being shipped. Foundations for the 250-ton mill and other plants have been completed. A large tonnage of 4.78-dwt. ore is awaiting extraction and treatment, and this is being increased by development. In the Ridge 8 and Mawe Meru mines, recently consolidated with Geita, appreciably higher values are being developed over good widths.

▶ Kimingini Gold Mining Company, operating in the Kakamega district of Kenya Colony, has reached a profit-earning stage, but has had to reduce milling to two shifts on account of depletion of available ore supply. Development at depth and drilling still deeper indicate diminishing to disappearing values below 600 ft. Considerable ore areas remain to be mined and explored at lesser depths.

▶ Globe & Phoenix Gold Mining Company, in Southern Rhodesia, is paying two dividends simultaneously, an interim of 1s. 6d. and a final of 1s., making 50 per cent, income-tax free, for the year. The chairman remarked at the annual meeting that over the 42 years of operations the dividends paid have averaged over 50 per cent per annum, though ore reserves have never been more than 1½ years ahead of the mill. The company has resumed development work on the old Globe reef, several times worked and abandoned, and is drilling the Bell mine, on which it has secured an option. The first hole in the latter revealed satisfactory values at a depth of 1,600 ft., which is below the old workings, and two more holes will be drilled.

▶ Regular milling operations have been started by Tanganyika Minerals, Ltd., in the Lupa district, following two years of tests. Ore developed is reported to average 9 dwt. per ton. Current earnings will be devoted to the retirement of debentures.

BRITISH ISLES

Iron Ore Beds Found In Drilling For Oil

Reserves thereby increased and fear of ore shortage relieved — Cornwall tin miners seek government subsidy

▶ The shortage of iron-ore and pig-iron supplies and fear of its intensification which prevailed in Britain a year or two ago have been relieved by increased production and imports. Supplies are now rather more than plentiful. By encouraging exploration the scare resulted in demonstrating that Great Britain's iron-ore resources are still far from exhaustion, known beds having been extended, and important new ones discovered. One of the later was unexpectedly brought to light when drilling for oil.

▶ Cornwall's tin-mining interests are asking the British Government for a subsidy sufficient to enable them to keep their properties in operation during periods of low prices, to the end that they may be able to supply national requirements

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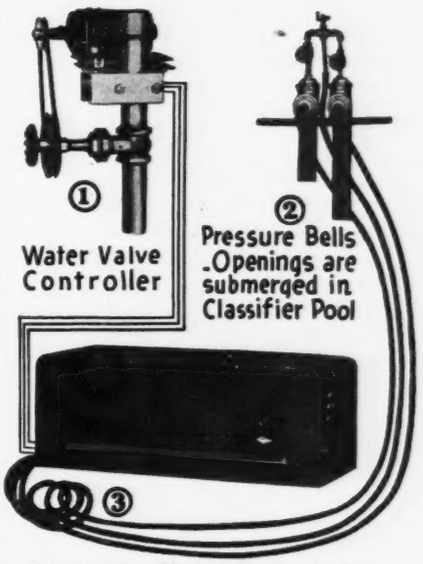

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▶BRITISH ISLES

in the event of war. It is considered probable that those who so strongly favor consolidations of considerable areas of the district, to be followed by a campaign of exploration and crosscutting, will be given a hearing.

PHILIPPINE ISLANDS

Japanese Interests Buy Base-Metal Output

Chromite ore shipments to United States curtailed—Commonwealth Government engaged in iron mining—New gold mines enter production.

▶ Political conditions in the Philippines have taken a turn for the better so far as the mining industry is concerned. Immediate independence seems definitely out of the question, and recent events have made it likely that American High Commissioner McNutt and the Joint Preparatory Committee (the American members at least) will not recommend complete severance from the United States in 1946. A re-examination of the whole situation has been proposed, and a trend toward some form of dominion status, instead of the establishment of a Philippine Republic, is now in progress. The continued warfare in China has brought about the realization that from China to the Philippines is but a short step. The eagerness with which the Japanese are acquiring property all over the Islands, and with which they are buying all base-metal ores available, indicates clearly enough that without American protection the Philippines would soon become a part of the Japanese Empire.

▶ A bill providing for the postponement of the enactment of that section of the New Mining Law (signed in November, 1936) has been prepared, and according to political leaders, will be passed before the close of the present session of the Assembly. Thus one danger to the industry will be postponed, for, as explained before (*E. & M. J.* Feb., 1938, p. 60), by the law no minerals can be extracted until a lease is granted, taxes can be raised at will, and there is considerable doubt as to whether leases would be granted except after long and costly delays.

▶ The Commonwealth Government is now itself engaged in the mining industry. Offers to develop large deposits of iron ore in Surigao, at the northern end of Mindanao, were made to the Government by a number of mining companies, among them several Japanese firms. After consultation with Dr. H. Foster Bain (former head of the United States Bureau of Mines), President Quezon announced in January that he had decided that the Government should exploit the property itself. Preliminary reports indicated that about 50,000,000 tons of low-grade ore, valued at around 25,000,000 pesos, can be produced. Dr. Bain left for the United States in March, and on his way stopped in Japan, presumably to arrange for the marketing of this ore. It was announced that Dr. Bain had estimated that the cost of bringing the property into production will be at least 100,000 pesos.

▶ An important development during the first quarter of the year has been the opening of negotiations between the Government and the Standard-Vacuum Oil Company (owned jointly by the Standard Oil Company of New Jersey and Socony-Vacuum Corporation of Delaware), for the development of Philippine oil fields. Though there are indications of oil in various parts of the Islands, not enough work has been done on any of them to prove the existence of commercial deposits. In 1935 about 40 companies were formed, mostly controlled by the same interests; President Quezon cancelled all of their leases, and only a few leases are now in effect. At the time of the cancellation President Quezon stated that he was afraid of a monopoly of the country's oil riches (when and if discovered), and preferred to let the deposits remain untouched rather than fall into the hands of a single group. At the time it was reported that Standard Oil was back of the group of companies, and the recent reopening of negotiations between Standard and the Government has aroused considerable interest.

▶ The collapse of the mining share market has been marked, and has interfered to some extent with the progress of a few companies which have encouraging properties. For the past month or so the daily business of the two stock exchanges has not been over a few hundred thousand pesos (as compared to million-pesos days during the boom). The International Exchange removed the pegged prices (imposed Sept. 10, 1937, when the market slumped severely) on March 4, but the Manila Exchange has so far kept the restricted prices on. Thus the lowest price at which Consolidated Mines can be sold at the Manila Exchange is 0.011 pesos per share; whereas at the International there is active trading at 0.0045 pesos. This situation is most confusing, and the investing public has definitely lost interest in mining shares until some solution can be arranged.

▶ Several companies have found it impossible to raise money for the construction of milling plants, and have been obliged to seek help from the large organizations. Other companies with properties under development have had to stop work because subscribers have not paid balances due on their subscriptions.

▶ Gold production passed the 5,000,000 pesos-a-month mark for the first time in March, and will probably be over that figure from now on. Several new operations have helped swell the total. Coco Grove started two new dredges in Paracale in January, and these are now working full time. The Tumbaga mine of Consolidated Mines has been producing since the first of the year (first report made at the end of the quarter); Surigao Consolidated completed its first month of operation at the end of March.

▶ Three new gold producers are now in operation, those operated by Surigao Consolidated Mining Company (Mindanao), Tinago Consolidated Mines (Masbate), and Consolidated Mines (Tumbagao property, Camarines Norte). Surigao Consolidated started a 200-ton

Production Statistics of Leading Philippine Mining Companies

Company	Tons Milled 1937	Total value 1937, Pesos	Average Value per Ton 1937, Pesos	Operating Cost per Ton, 1937, Pesos	Operating Profit per Ton, 1937, Pesos	Daily Mill Capacity Tons	Estimated Ore Reserves of Jan. 1, 1938 — Tons,	Estimated Ore Reserves of Jan. 1, 1938 — Value, Pesos	Dividends paid in 1937, Pesos	Value of Production, 1936, Pesos	Value of Production, 1935, Pesos
Antamok Goldfields Mining	253,794	5,235,398	20.63	11.18	10.88	800-900	534,959 (1)	5,896,722	3,575,000	5,038,071	2,490,980
Baguio Gold Mining Company	74,322	1,247,411	16.78	14.00	3.08	250	183,306 (2)	3,317,839	194,935	1,054,562	876,245
Balatoc Mining Company	444,659	13,014,511	29.25	15.05	14.73	1,200	1,401,514 (1)	24,322,158	6,000,000	12,788,924	12,544,342
Benguet Consolidated Mining	318,740	9,886,190	31.02	16.29	15.36	1,000	1,108,045 (1)	18,755,330	6,000,000	9,015,114	8,632,056
Benguet Exploration, Inc	38,366	265,725	6.93	6.87	.06	120	34,400 (2)	300,340	.....	274,404	269,662
Big Wedge Mining Company	42,166	1,388,979	32.94	16.73	16.73	150	87,155 (2)	2,604,258	.....	591,547	.....
Cal Horr Mine	70,903	1,267,588	17.88	11.49	7.42	200	87,219 (1)	1,097,425	.....	922,140	.....
Demonstration Gold Mines, Ltd.	93,562	1,664,008	17.75	13.22	5.44	200,250	134,836 (2)	3,293,238	400,000	1,476,345	930,343
East Mindanao Mining, Inc.*	39,005	691,853	17.74	17.53	7.19	100	25,251 (2)	548,845	.....	213,458	.....
Ipo Gold Mines, Inc.*	65,688	622,350	9.47	8.67	1.68	200	44,030 (1)	471,062	140,933	641,965	575,039
Itogon Mining Company	261,396	3,359,331	14.75	10.32	4.84	1,000	424,700 (2)	5,648,510	300,000	2,823,543	2,212,494
I X L Mining Company	90,405	2,220,567	24.56	14.20	11.86	325	299,295 (2)	6,694,425	837,500	1,275,627	356,002
Masbate Consolidated Mining	619,364	2,966,128	4.79	4.13	.66	2,000	9,662,002 (2)	60,960,039	.....	2,009,543	540,340
Royal Paracale Mines, Inc.	16,628	148,404	8.88	.....	.....	100	..... (2)	631,855	.....	.....	.....
San Mauricio Mining Company	68,539	1,879,164	27.42	22.25	7.94	300	143,198 (2)	3,477,422	.....	1,798,150	.....
Suyoc Consolidated Mining Company	75,972	1,445,478	19.03	15.40	4.48	350	258,700 (2)	5,348,700	.....	1,130,899	790,032
Tambis Gold Dredging Company, Inc.*	(a) 321,720	149,497	(a) 0.46	(a) 0.28	(a) 0.18	Dredge	.....	.....	30,299	106,368	131,327
United Paracale Mining	106,689	1,902,051	17.83	14.23	5.29	350	121,083 (2)	2,798,074	.....	1,296,644	528,353

* From Oct. 31, 1936, to Oct. 31, 1937. (a) Cubic yards.

(1) — Au @ $20.67
(2) — Au @ $35.00

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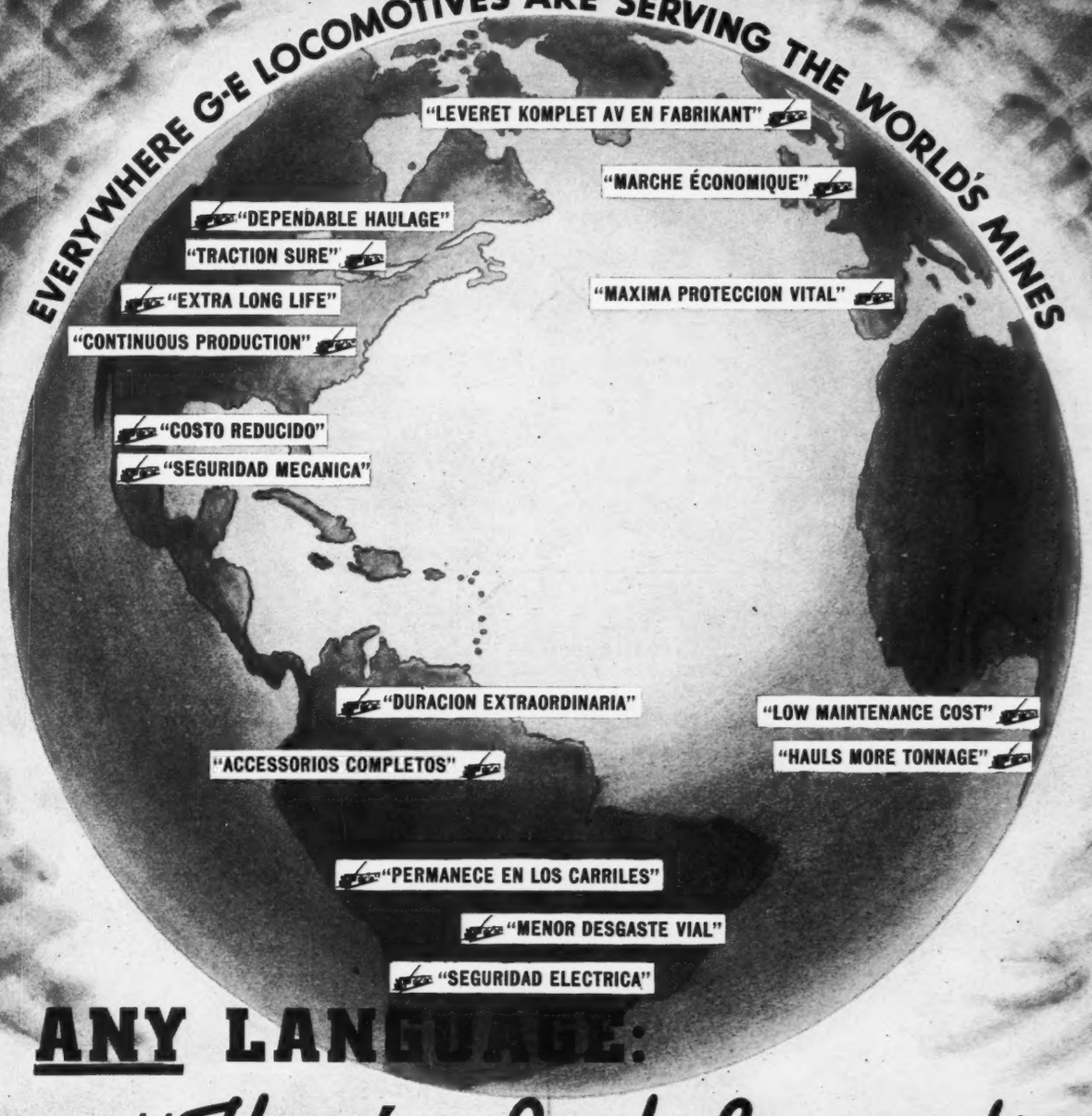

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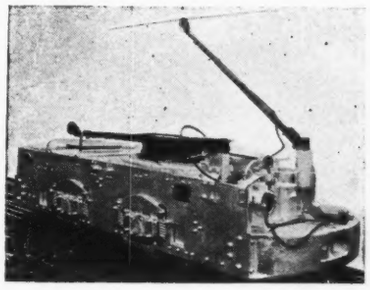

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▶PHILIPPINES

cyanide plant in March. Nielson & Company, general managers, completed the Tinago 50-to-75-ton cyanide plant about March 10. The Tumbaga plant has been running since late December.

▶ In addition to these, all new operations, several other new plants are under construction. The Soriano interests have awarded the contract for a 300-ton cyanide plant for the North Camarines Gold Mining Company to Southwestern Engineering of P. I. (a subsidiary of the company of the same name of Los Angeles, Calif.) and it is expected to be in operation by the end of the year. About 100 tons of ore from the Mambulao Consolidated Mining Company, also a Soriano-managed company, will be treated at this mill.

▶ Macawiwili Gold Mines, Inc., has awarded a mill construction contract to Southwestern Engineering, for a 100-ton plant at its property in the Baguio district. The Paracale-Gumaus Consolidated Mining Company plant of 100-ton capacity (being built by Nielson & Company, general managers) is nearing completion, and should be ready to turn over by the middle of April. The 150-ton cyanidation-flotation plant of the Santa Rosa Mining Company in Camarines Norte is expected to start production during May.

▶ Batong Buhay Gold Mines, Inc., Paracale Gold Mining Company, Capsay Mining Company, Masbate Goldfields, Mapaso Goldfields, Nalesbitan Venture, Santa Teresita Mining Association, and Treasure Islands Mining Company all plan to have milling plants in operation by the end of this year.

▶ Samar Mining Company (operated by the Elizalde interests) made its first shipment of iron ore to Japan in February, amounting to around 6,500 tons. Production for March was about the same. It is planned to increase output gradually so that by the end of the year around 20,000 tons will be shipped each month. This ore averages around 60 per cent iron, and has all been contracted by Japanese buyers.

▶ The Philippine Iron Mines is continuing its shipments of iron ore to Japan, at the rate of 50,000 to 60,000 tons per month.

▶ The base-metal industry otherwise is not faring so well. In March Benguet Consolidated announced that no further shipments would be made for the present from the deposit in Masinloc owned by Consolidated Mines and being operated by Benguet on a profit-sharing basis, because United States buyers were sufficiently stocked. Shipment from the high-grade Florannie deposit is continuing, and it is expected that the entire 100,000 tons available will have been shipped by the middle of the year.

▶ The Acoje Mining Company received word from the States in March that no further shipments would be required; consequently its chromite property in Zambales has been shut down pending new orders. A small amount of chromite is being shipped to Japan.

▶ Shipments of manganese ore have been made intermittently since the first of the year, chiefly to Japan by Mine Factors, Inc., through Amalgamated Minerals, ore buyers. Considerable difficulty has been experienced in keeping this ore up to quality; high moisture and phosphorus content penalties have lowered the value to the mining company from an estimated 19 pesos to around 10 pesos per ton.

▶ Amalgamated Minerals is also shipping copper ore, and Lepanto Consolidated, north of Baguio, is sending copper concentrate regularly to Japan.

▶ Steps are being taken by the Soriano interests for the listing of the stocks of Antamok Goldfields Mining Company, I. X. L. Mining Company, Masbate Consolidated Mining Company, and Eastern Development Company (holding concern) on the San Francisco and Los Angeles stock exchanges. These companies will be the first Philippine mining firms to appear on American stock exchanges.

▶ At the annual meetings of the Soriano companies a plan whereby funds now held in reserve for depletion and depreciation will be invested in African gold mining projects was announced. An investment trust, known as Anta-m-ixl, has been formed in Hongkong, with a capital of 300,000 pesos, for the purpose of investing in promising properties outside of the Philippines. The plan of operation provides that after all speculative risk has been eliminated (in other words, after a property has been developed to the point where a mill is justified) that part of all of the reserve funds set aside for depreciation and mine amortization by Antamok Goldfields, Masbate Consolidated, and I. X. L. be invested in this trust.

AUSTRALIA

Large Dredge Will Exploit New Tin Placer Area

Production expected to start late this year at the rate of 1,000 tons of tin concentrate annually

▶ In its property at Return Creek, Mount Garnet, N. Q., Tableland Tin Dredging, N. L., possesses the only proved Australian example of a large-scale tin-dredging proposition. So far some 80,000,000 cu.yd., expected to yield an average of ½ lb. tin oxide per cubic yard, have been proved. The property is to be equipped with an 18-cu.ft. electric dredge designed to treat over 4,000,000 cu.yd. annually, with an annual yield of 1,000 tons of tin concentrate. As delivery of the large dredge will be slow, an existing dredge taken over with the property is being reconstructed and modernized, and will be set to work digging at the rate of 80,000 cu.yd. monthly, in about six months' time. A net profit of £3,000 per month is expected from the operation of this dredge, which will be kept in service after the large unit goes into operation. Design of the large dredge is in the hands of Alluvial Mining Equipment, Ltd., of Sydney, under the direction of G. H. Watson.

▶ A new discovery of gold is reported from Western Australia. An outcrop carrying rich values has been located 1½ miles from Cox's Find, where the Western Mining Corporation is operating the Erlistoun mine with marked success.

▶ Wattle Gully Gold Mines, N. L., Chewton, Vic., is maintaining values at depth, the lode having been crosscut with good width and values at the 800-ft. level, 145 ft. below the present bottom working level. It is intended to sink a new shaft now that the position of the lode at the 800-ft. level has been determined. W. Till is mine manager.

▶ The enterprise of Bendigo Mines, N. L., which spent about half a million pounds in the development of large areas on the Bendigo field, has come to an end with the closing-down of the last operating subsidiary, Carshalton Mines, N. L.

Cyanidation-treatment operations at Tennant Creek, Northern Territory, Australia—Leaching operations are carried out in shallow heavy-gage galvanized iron tanks

NEW BOOKS

GRAPHIC ROUTES TO GREATER PROFITS. *By John W. Esterline. The Esterline-Angus Company, Indianapolis, Ind. Pp. 320. Illustrations 439. Price $3.*

ONE of the great contributions of science to industry has been the introduction of quantitative methods of measuring the efficiency of machines and processes. In the absence of such quantitative measurements the operator must perforce rely on rule-of-thumb or empirical knowledge, with attendant loss and waste. Hence the adequate instrumentation of an industrial plant with indicating and recording devices becomes a matter of economy.

Mr. Esterline's book is a volume of experience on the use of graphic instruments for increasing the capacity and efficiency of industry. It contains more than 250 case studies, many of which relate directly to the mining and metallurgical industries. For example, the operation of air compressors, the maintenance of electric motors, the control of ventilation, and the production of electrogalvanized wire. The author first discusses the high cost of inefficiency in plant operation, and then illustrates his general thesis with problems of power, machines, processes, and men. Finally, a number of research and special problems are illustrated. The volume is a practical contribution to the art of applying the scientific method to the conduct of industrial operations.

UNDERGROUND PRACTICE IN MINING. Second Edition. *By Bernard Beringer. Mining Publications, Ltd., Salisbury House, London. Pp. 277. Price 21s.*

IN THIS SECOND and enlarged edition of the book that appeared in 1928, the subject is treated under ten headings in the space of twenty chapters. The outline is practical and confines itself to the limits indicated by the title. At the outset the topics of support of workings, shafts, subsidiary development, and stoping are successively presented, followed in order by those of underground transport, blasting, compressed-air practice, ventilation, mine sampling, and organization. The exposition is clear and adequate. Where specimen calculations are desirable, as in the pages on ventilation, they are provided. Over 200 illustrations are included. Author and publisher have cooperated to produce an informative and useful book that is also of convenient size and weight. In it is reflected the new experience gained by Mr. Beringer during the years that have elapsed since he prepared the earlier volume.

DIE METALLISCHEN ROHSTOFFE. *Ihre Lagerungsverhältnisse und ihre wirtschaftlichhe Bedeutung. Vol. 2. Molybdän, Monazit, Mesothorium. By Geh. Rat. Prof. Dr. Paul Krusch. Published by Ferdinand Enke Verlag, Stuttgart, 1938. Pp. 87; 8 illustrations and 9 tables; paper bound. Price: Rm. 6.00 (less 25 per cent in foreign countries).*

IN THIS second pamphlet of the projected series of fifteen dealing with the metallic raw materials of the world, Professor Krusch closely follows the principles and method of presentation employed in his Vol. 1, which was reviewed in the January, 1938, issue of this publication.

As the author pointed out in the Introduction to Vol. 1, the principal purpose of this work is to present a review of the world-knowledge on the economic geology of metals and to acquaint the German geologists with the recent developments in this field. After reading Vol. 2, however, special significance must be attached to the avowed connection of this publication with the success of the economic four-year plan currently pursued in Germany. It seems to be eminently desirable to make the Reich self-sufficient in raw materials as well as in their economic exploitation. This tendency of thought and purpose is becoming increasingly apparent and serves to impair the value of this work in the eyes of the objective student.

Molybdenum is the principal metal under discussion in the present pamphlet. After a short historical introduction and some general notes on its occurrence in the earth's crust, Professor Krusch launches a rather detailed, though by no means balanced, description of the various individual ore deposits. The occurrence at Climax, Colo., which produced four-fifths of the world supply of molybdenum in 1934, is the first to be treated in this chapter. All of 4½ pages are devoted to its discussion, which includes a simple geologic map, a production table, and ample historical information. The geology of the deposit is also hinted at.

Discussion of numerous ore localities in Canada, Scandinavia, Finland, Russia, Peru, Japan, Australia, etc., take up additional seven pages. The bulk of descriptive matter, involving some 23 pages of this chapter, however, deals with deposits in Germany and Austria (now included in the Greater Germany), which are so negligible from the economic point of view that the molybdenum production of these countries is not even listed in the quoted tables published by the United States Bureau of Mines and the Reich.

The purely geological information contained in this portion of the text is accurate enough as long as the reader abstains from drawing any conclusions of an economic nature. In view of this partiality of presentation it is rather significant that recent figures on German mining and production of molybdenum are consistently absent. An interesting sidelight is also thrown on the economic conditions of the present-day Reich, when the author urgently advocates a *profitable* yearly production of 40 to 50 tons of the metal. (The U.S.A. alone produced nearly 7,800 tons in 1936.)

Information on the chemistry of molybdenum and on the refining methods of the crude ore will be of interest to the mining engineer and metallurgist.

Monazite and the element mesothorium, derived from it, are discussed in the closing pages of the pamphlet. The author admits that Germany has no source of the metal at present, but is equipped to refine it because of its early connection with the exploitation of the Brazilian monazite sands. The placer deposits of Brazil and India are particularly dealt with and some information is given on the radioactive properties of mesothorium and its commercial application as a cheaper source of rays effective in the treatment of cancer.

The author continues the laudable practice of giving long lists of references to the world literature, a fact which begins to loom as the primary value of this series of publications to the unbiased geologist.

KURT E. LOWENSTEIN

PUBLICATIONS

RECEIVED

✦ *Geology and Ore Deposits of the Tombstone District, Arizona.* By B. S. Butler, E. D. Wilson, and C. A. Rasor. Arizona Bureau of Mines, Tucson, Ariz. Pp. 114, with a supplement of 27 separate maps.

✦ *Ceramic Materials in Tennessee.* By George I. Whitlatch. Division of Geology, State of Tennessee, Nashville. Pp. 19.

✦ *Steel Products Manual.* Section 19, Railway Track Materials and Section 20, Wrought Steel Wheels. American Iron and Steel Institute, New York. Pp. 15 and 14, respectively.

✦ *The Mineral Industry of Alaska in 1936.* By Philip S. Smith, U. S. Geological Survey Bulletin 897-A. Pp. 107. Price 30¢.

✦ *Laboratories That Make Assays, Analyses, and Tests on Ores, Minerals, and Other Substances.* By C. W. Davis and M. W. von Bernewitz. Information Circular 6999. U. S. Bureau of Mines, Washington, D. C. Pp. 25.

✦ *Ball Mill Grinding.* By W. H. Coghill and F. D. DeVaney. Technical Paper 581, U. S. Bureau of Mines, Washington, D. C. Pp. 56. Price 15¢.

✦ *Manganese Resources of the Tennessee Valley Region.* By H. S. Rankin, R. A. Laurence, and F. A. W. Davis. Geologic Bulletin No. 7. Tennessee Valley Authority, Knoxville, Tenn. Pp. 30.

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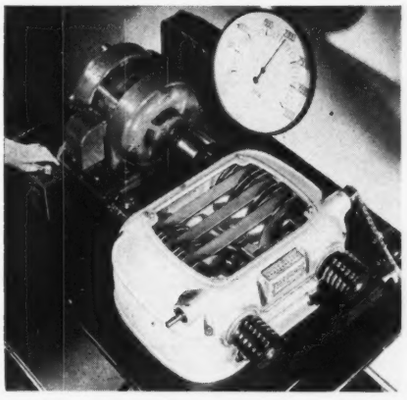
EQUIPMENT NEWS

Vari-Pitch Speed Changer

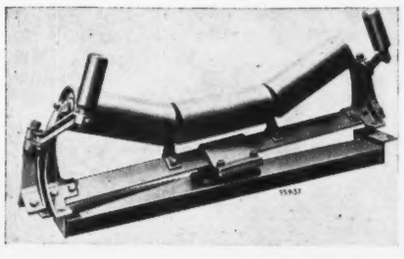
THE TEXROPE Division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces a new speed changer unit said to open up new horizons in variable speed transmission. It utilizes the principle of that company's multi-



groove vari-pitch sheaves. The new speed changer consists of a ruggedly constructed, compact, totally inclosed unit, designed with double shaft extensions and driven from a standard motor, said to provide the flexibility that makes it adaptable to a wide variety of layouts to suit the individual application. Where the change in speed is to be adjusted manually only, the unit is provided with a readily accessible handwheel control. However, the unit can be equipped for electric remote control. Manual remote control is also possible. The range of capacities now being offered includes ratings up to 33 hp. with ratios as high as 3¾ to 1. It is expected that larger ratings will be developed.

Self-Aligning Belt Idler

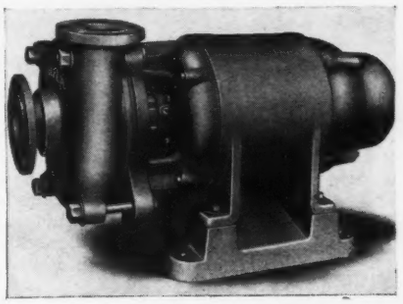
A NEW self-aligning idler for training conveyor belts automatically without damaging the belt is announced by Jeffrey Manufacturing Company, Columbus, Ohio. It consists of a standard antifriction idler pivotally mounted on a supporting cross member, with guide rolls at each end. These guide rolls are



mounted on pivoted arms that extend at right angles to the idler in the direction from which the belt approaches. The arms are held in place by an easily removed locking pin. Merely by swinging the arms through 180 deg. and putting the lock pin in place on the opposite side, the guides are made ready to train the belt when traveling in the reverse direction. As there is no pressure between the guide rolls and belt, there can be no damage to the edge of the belt. The guide roll moves outwardly the instant the belt touches it, and in so doing swivels the idler sufficiently to cause the belt to return to normal position.

New Centrifugal Pumps

A NEW centrifugal pump without a stuffing box is announced by A. R. Wilfley & Sons, Box 2330, Denver, Col. Known as Model "AB," it is a centrifugal pump of unitary construction with the wetted pump parts built directly onto an electric motor. Construction is said to be rugged and compact, and the pump

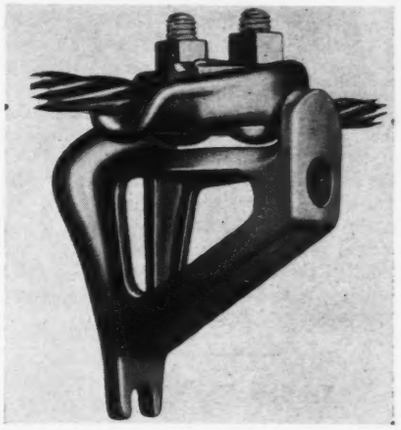


has typical suction characteristics and can be used on suction lifts. Elimination of the stuffing box is said to be accomplished by a unique hydraulic circuit at the back of the impeller. Any slippage of the liquid through the labyrinth formed by the impeller and the replaceable rings in the case plate is caught and returned to the volute of the case by the secondary, or expeller, vanes of the impeller.

No rubbing contact between any rotating or stationary parts is said to be experienced when the pump is running. When the pump moves down to "stop," the shaft is moved endwise mechanically, thus bringing the conical surfaces of the rotary and stationary seal rings into contact, preventing leakage of the fluid. Upon starting, the reverse movement is said to take place. Features mentioned by the manufacturer are that the wetted pump parts are of heavy sections; the ball bearings are the heavy double-row type which will run for many months on a greasing, and the elimination of the stuffing box and all rubbing contacts makes the pumps ideal for 24-hour continuous service without attention. Models AB and AC are available for quantities from 1 to 1,000 g.p.m. and for heads up to 150 ft., and some high-speed assemblies will develop heads up to 300 ft.

Wire Bracket

USING A CLAMP mounted on top of the device, a bracket for supporting overhead ground wires on wood pole lines, developed by the Ohio Brass Company,



Mansfield, Ohio, saves 6 in. or more of pole height over previous designs. The bracket proper has two pintles on which the clamp body rests. Two carriage bolts hold the clamp to the bracket and secure the keeper piece over the ground wire. Since the clamp pivots 15 deg. above or below the neutral position, ample clearance for rocking action is provided. The wire is secured by simply placing the keeper piece over the wire and tightening the bolts. The clamp holds any wire from ¼ to $\frac{9}{16}$ in.

New Pulp Density Controller

MEANS of controlling pulp density automatically and continuously in the classifier overflow of a ball mill-classifier circuit is offered by Mine & Smelter Supply Company, Denver, Colo., in a new mechanism that regulates the flow of dilution water. Claim is made that percentage of solids can be maintained within 1 per cent of any predetermined density. The device consists of two pressure bells of unequal length with openings submerged in the classifier pool, a controller mechanism, and a motor-operated valve. The controller mechanism contains a small motor-driven air compressor that supplies air to the pressure bells, displacing two unequal columns of pulp. Back pressure due to pulp density is reflected to two sensitive diaphragms which actuate an electrical contact connected with the dilution valve. Any variation in classifier pulp density opens or closes the dilution water valve by a fraction of a turn and thus maintains a steady ratio of solids to solution. When the desired ratio is once established by test, the controller is set in operating position by moving a weight on the

density-control arm until the indicator arm and electrical contact are in neutral position. This setting can be made for any desired solid-solution ratio, and will reflect any changes from the established density.

New Blueprint Paper

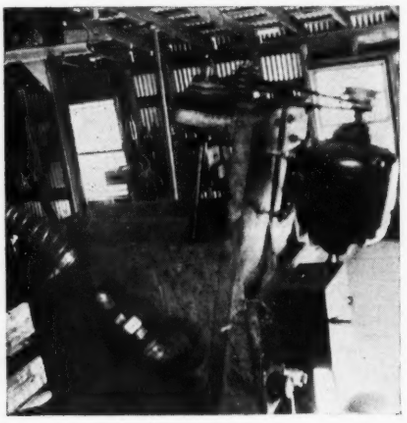
A NEW TYPE of blueprint paper has been announced by Keuffel & Esser Company, of Hoboken, N. J. The improved papers are named "Series Sixty," and are said to produce prints of an unusually deep blue color, so that the white lines of the reproductions stand out in sharp, legible contrast. This extra color strength gives blueprints a high contrast ratio, and it makes them as legible as original drawings. An exceptionally wide printing range is also claimed for the type of blueprint papers. Tracings of varying transparency can be printed successfully at a single setting of the machine—or strong blueprints can be made from any tracing within a broad range of machine speeds. They are handled the same as conventional papers —printed and washed with the same equipment and procedure.

Trolley Guard Rubber

B. F. GOODRICH COMPANY, Akron, Ohio, announces a trolley guard rubber for use in mines operating electrically-driven cars with overhead trolley wires. The device consists of a cloth-inserted rubber sheet $\frac{3}{32}$ in. thick by 9 in. wide and is made in 25-ft. lengths. The sheet is folded double and given a secondary cure so that it will remain in a U shape. It is attached by simply slipping over the trolley like a saddle and cutting notches or holes at intervals for fitting around the trolley supports. Danger of the miner's head or tools coming in contact with the bare trolley is said to be eliminated because the rubber will flex together and bend readily in either direction. At the same time, however, it is said the feeder pole of the car motor will slip through the slot of the guard without obstruction.

Electric Amalgamator

THE KROLL Electric Amalgamator recently announced by the Caird Engineering Works, Helena, Mont., was designed for the saving of finely divided gold as well as coarse gold, and especially the type of gold which is coated or rusty and not subject to amalgamation with mercury by ordinary means. This amalgamation of refractory gold is said to be brought about by a combination of the following three principles, either singly or in combination, as the circumstances may require: (1) The construction of the machine is such that all pulp which is passed through it is brought into intimate mechanical contact with a pool of mercury which is placed in the bottom of the cell. (2) Suitable chemicals are added to the mill circuit solution to bring about the necessary chemical changes which will allow amalgamation and/or precipitation of the metals. (3) The pool of mercury in the bottom of the cell forms an electrical cathode to which a source of electric current of



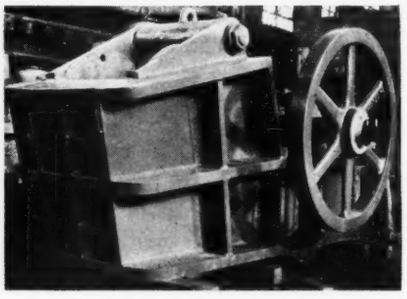
the proper voltage, frequency, and amperage is applied so as to produce electrochemical action in the circuit solution. The anode for completing the electrical circuit consists of a plate which is insulated from the mercury cathode. Material used in the anode varies with the reagent used and the results desired.

The manufacturer believes Kroll Electric Amalgamator should be useful in the extraction of many metals, but so far the only tests conducted have been for the extraction of gold and silver. Power requirements are said to be approximately $\frac{1}{2}$ hp. per cell. The capacity of a single cell unit ranges from 5 to 20 tons per 24 hr., depending on the material to be treated.

Safety Goggle

A NEW TYPE spectacle goggle, equipped with super-tough lenses and designated as Style WVI, has been added to the line of goggles manufactured by Willson Products, Inc., 260 Thorn St., Reading, Pa. Designed for maximum protection and comfort, this new goggle is available in various assemblies to suit the individual requirements, for use in industries where falling or flying objects present a serious eye hazard.

The goggle is equipped with clear, wide-view lenses and rocker nose pads: it is also made with comfortable, broad-saddle nose bridge. The goggles are said to be available with wire screen, leather, or transparent sonite sideshields, and with Willsonite lenses when specified.



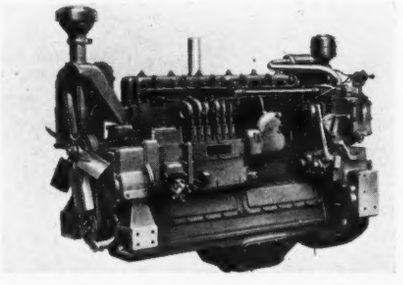
The latest 30x36 in. Type H jaw crusher of the Traylor Engineering & Manufacturing Company, Allentown, Pa., is said to employ the refinement of smooth-faced curved jaw plates of a design that employs the principle of the non-choking bell-head and curved concaves that are said to be more economical in steel consumption

Roto-Clone Fan

TYPE W ROTO-CLONE is a recent development of the American Air Filter Company, Inc., Louisville, Ky., in which the wetting effect of water is combined with the dynamic principle of dust separation to obtain increased collection efficiency with lighter and finer dust particles. By introducing a water spray at the inlet of the Type W Roto-Clone, higher collection efficiencies are obtained with fine dust that can be wetted. The "weighting" of the dust particles with the water spray and their impingement on the wetted surfaces of the impeller make it possible to separate and collect a wider range of particle sizes. The flowing film of water on all metal parts also eliminates wear from abrasive dusts. A constant air volume is exhausted at all times, and no maintenance is required other than the periodic removal of the collected material. The collected dusts discharge in the form of a light sludge into a settling tank. A sludge ejector can be furnished which removes the sludge continuously and makes this operation entirely automatic.

Diesel Engine

OFFERING an industrial engine for the smaller power user, Caterpillar Tractor Company, Peoria, Ill., announces the addition of the diesel D3400 model to its



current line. The new engine is a four-cylinder model with $3\frac{3}{4}$-in. bore and 5-in. stroke. It develops 33 hp. at 1,525 governed r.p.m. The D3400 engine is generally similar to other "Caterpillar" diesels, featuring the four-stroke cycle, valve in head, water-cooled design, with solid fuel injection into precombustion chambers. In construction work, the engine is the proper size for powering smaller portable equipment, $\frac{3}{8}$-yd. draglines and shovels, and smaller industrial locomotives. Connected to a 15-kw. generator, it will provide smooth, even power for all-night service stations and mining camps. It is also well suited for irrigation work and other pumping jobs within its capacity.

Vertical Welder

HARNISCHFEGER Corporation, of Milwaukee, Wis., announces a new machine

VERSATILE

PURCHASED FOR ONE DUTY ...now assigned to 3

As a means of lowering stripping costs, Michigan Limestone and Chemical Company placed a LeTourneau 12-Yard Carryall Scraper in service at their Rogers City quarry.

On this kind of work the Carryall proved it can do more than was bargained for. It strips overburden at the rate of over 100 yards per hour . . . then, down in the quarry, it does secondary stripping of blasted limestone rock and fines.

. . . then, to cinch the title, "jack-of-all-trades" . . . and a *master* of each, job engineers found it ideal for constructing their dikes for settlement basins . . . and building and maintaining roads to, and on, the fines dump, with but little time out from regular duties.

In mining and quarrying, LeTourneau Carryalls offer much and ask little—saving time and money at a rate that soon clears their initial cost. They ask no favors for they have earned their reputations on the world's really tough jobs . . . it's the "pioneering spirit" and stock from which they are built that keeps 'em going in most any formation.

For facts or recommendations and estimates on *your* job: See your nearest "Caterpillar" dealer . . or write us.

R. G. LeTOURNEAU, Inc.

PEORIA, ILLINOIS STOCKTON, CALIFORNIA

Cable address: "Bobletorno"

Manufacturers of: Angledozers*, Buggies*, Bulldozers, Carryall* Scrapers, Cranes, Drag Scrapers, Power Control Units, Rooters*, Treedozers.

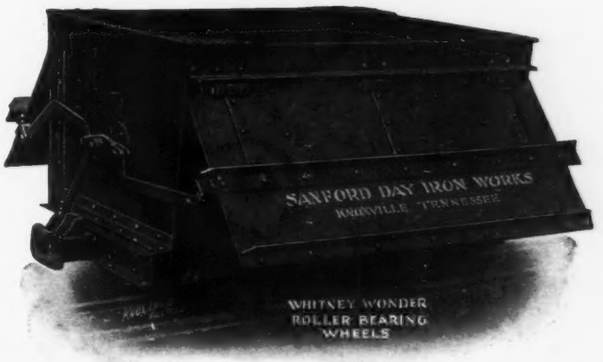
*Name registered U. S. Patent Office.

LETOURNEAU

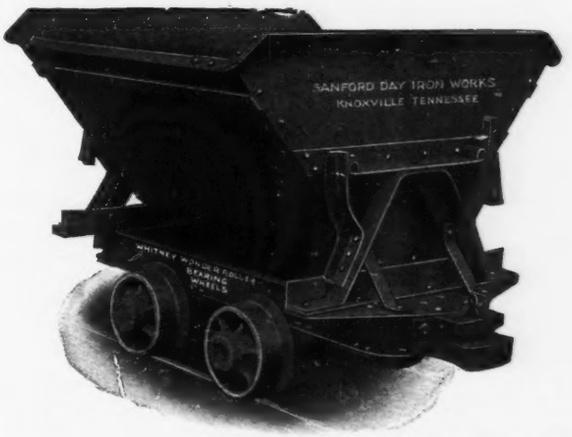
You Can't Meet Competition

With OBSOLETE Equipment

Modernization . . . replacement . . . purchase of new, up-to-date, faster, more efficient equipment is a cost-cutting necessity. Progressive mines everywhere are junking obsolete mine cars—coming to Sanford-Day for modern cars to help them meet competition. And, regardless of type or capacity, Sanford-Day produces mine cars for every mining requirement.



A Sanford-Day Gable Ore Car, used by some of the largest metal mines in the United States.



A Sanford-Day V-Shape Rocker Ore Car. S-D "Floater" Ball Bearing Wheels (Patented Annealed) now available for all types of cars.

SANFORD-DAY IRON WORKS

KNOXVILLE • TENNESSEE • U. S. A.

in its line of P&H-Hansen electric arc welders—the 150-amp. vertical-type welder. The unit is designed to occupy a minimum of floor space, and is available for a wide range of work in welding the lighter-gage metals, both ferrous and non-ferrous. It is designed for high current uniformity, and is an ideal unit for use in the production welding line where smooth, uniform welds are essential. Furnished in the a.c. drive only, this machine is less than 4 ft. in overall height.

BULLETINS

Flotation Unit. Denver Equipment Co., 1400-1418 17th St., Denver, Colo. Bulletin 3801-T has blueprint specifications of the Denver Twin flotation unit.

Steel Derricks. American Hoist & Derrick Co., St. Paul, Minn. Catalog D1-2-38-10M describes construction and operating features of small-, medium- and heavy-duty derricks. Pp. 25.

Coils. Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. Folder describes the Vitrotex, magnet wire and coils that are insulated by a fine glass textile. Pp. 2.

Power Pumps. Fairbanks-Morse & Co., Chicago, Ill. Bulletin 6185 illustrates and describes features of the company's 6184 and 6185 duplex self-oiling power pumps. Pp. 5.

Portable Electric Tools. Black & Decker Mfg. Co., Towson. Md. Annual catalog illustrates and gives price list of the manufacturer's line of portable electric tools. Pp. 54.

Photo-reproduction. Fotoflex Co., 636 Sixth Ave., New York, N. Y. Folder describes compact device for making photo reproductions of typewritten, handwritten, printed or drawn, and of pictorial representation in every medium. Pp. 2.

Diesel-Electric Generators. Caterpillar Tractor Co., Peoria, Ill. Bulletin 4658 illustrates and describes use of diesel-electric generators in mining, dredging, and other industrial fields. Pp. 11.

Chrome Refractory Cement. Tingley Company, 56 West 45th St., New York, N. Y. Bulletin 322-B describes the manufacturer's neutral chrome base refractory cement for use in metallurgical and boiler furnaces to resist high-temperature effects and destructive slagging. Pp. 4.

Mine-Car Couplers. Ohio Brass Co., Mansfield, Ohio. Bulletin 646-AM gives complete operating and technical description of the company's new O-B automatic mine and industrial car coupler. Pp. 12.

Portable Brinell Meter. Louis C. Eitzen Co., 280 Broadway, New York, N. Y. Small folder describes operation of the Brinell test for determining metal hardness with the manufacturer's portable Brinell meter.

Electric Drive Selection. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Bulletin 2130, arranged for the plant maintenance man, describes and illustrates the requirements which must be met in selecting a motor. Pp. 12.

Ferro-Therm Insulation. American Flange & Mfg. Co., Inc., 30 Rockefeller Plaza, New York, N. Y. Bulletin describes advantages of insulating buildings and homes with the manufacturer's light-weight metal sheets. Pp. 11.

Vacuum Pumps. Fuller Co., Catasauqua, Pa. Bulletin C3-A describes and illustrates features of the company's single- and two-stage compressors and vacuum pumps. Pp. 16.

Hytor Compressors. Nash Engineering Co., South Norwalk, Conn. Bulletin 276 describes the company's new 75-lb. pressure compressor having one moving part, no valves or pistons, and no internal lubrication. Pp. 7.

Processing Equipment. The Dorr Co., Inc., 570 Lexington Ave., New York, N. Y. Bulletin 7071 describes and illustrates the manufacturer's processing equipment for agitation, classification, and thickening. Pp. 7.

Totalizing Scale. Toledo Scale Co., Toledo, Ohio. Folder describes the manufacturer's latest weight indicator that may be placed at the scale or at some distant point for convenient observation. Pp. 4.

Magnetic Separation. S. G. Frantz Co., 161 Grand St., New York, N. Y. A well-illustrated brochure presenting operating features of screens that remove iron from liquids and liquid-solid mixtures. Pp. 16.

Wire Screens. Korb-Pettit Wire Fabrics Iron Works, Inc., 1505 North Mascher St., Philadelphia, Pa. Bulletin 25 describes the manufacturer's types of meshes and gages of wire for every screening service. Pp. 8.

Multi-Wash Dust Collector. Claude B. Schneible Co., 3951 Lawrence Ave., Chicago, Ill. Folder describes the manufacturer's Junior dust collector for small plant installations. Pp. 3.

Rotary Pumps. Foster Pumps Works, Inc., 50 Washington St., Brooklyn, N. Y. Bulletin 1001 describes the company's line of Excelsior rotary pumps. Pp. 12.

Electric Motors. Louis Allis Co., Milwaukee, Wis. General Bulletin 700-A describes sizes and types of the manufacturer's electric motors for every industrial requirement. Pp. 58.

Socket Instruments. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Catalog Section 43-600 describes Type E sockets for outdoor and indoor industrial plants. Pp. 20.

Variable Reducer Transmission. Stephens-Adamson Mfg. Co., Aurora, Ill. Catalog 68 illustrates and describes the manufacturer's variable-speed transmission and speed reducer. Pp. 12.

Power Shovel. American Hoist & Derrick Co., St. Paul, Minn. Catalog GS3 describes features of the company's ½-cu. yd. shovel, Model 350. Pp. 25.

Vibrating Screens. Deister Concentrator Co., Fort Wayne, Ind. Bulletin 14-H illustrates and describes the latest improved Model C Leahy heavy-duty vibrating screen. Pp. 19.

Oil Tractors. Allis-Chalmers, Milwaukee, Wis. Bulletin form No. M. S. 223 describes the features of the Model S. O. controlled-ignition oil tractor for various hauling and excavating purposes. Pp. 34.

Fan-cooled Induction Motors. Leaflet 2124A describes Type A-R-Z totally inclosed fan-cooled induction motors. Pp. 3.

Roofing Materials. Johns-Manville, 22 East 40th St., New York, N. Y. Title of book is "Johns-Manville Bonded Built-Up Roofs." It contains 40 complete specifications on J-M built-up roofs. Pp. 36.

Remote Transmission. Brown Instrument Co., Philadelphia, Pa. Folder 94-1 describes the manufacturer's system for remote transmission of measurement and control in hazardous atmospheres. Pp. 4.

Variable-Speed Transmission. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1266 describes and illustrates the manufacturer's Vari-pitch speed changer. Pp. 10.

Shovel Excavator. Bucyrus-Erie Co., South Milwaukee, Wis. Bulletin 29.B1 illustrates and describes the company's new Bucyrus-Erie 29B 1-yd. excavator. Pp. 32.

Calyx Core Drills. Ingersoll-Rand Co., Phillipsburg, N. J. Catalog 9501-A illustrates the manufacturer's complete line of calyx core drills for boring holes in rock and concrete from 2¼ in. to 72 in. diameter, and to depths of 2,500 ft. Pp. 42.

Electric Instruments. General Electric Co., Schenectady, N. Y. GEA-602 F is a loose-leaf book illustrating and describing indicating and recording instruments for various uses, portable transformers, high-precision instruments, and numerous miscellaneous instruments; pp. 179. GEA-1929A describes gear motors; pp. 6. GEA-2716 bulletin mentions features of d.c. cam-type drum switches, pp. 6; Bulletin GEA-2742 describes pyranol capacitors for low-voltage industrial applications; pp. 23. Leaflet GEA-841H describes a.c. magnetic switch; GEA-432C describes and illustrates Type CD d.c. generators and exciters; pp. 3; GEA-1283A describes cam-operators' master switches. GEA-2726A mentions features of outdoor oil-blast circuit breakers. Pp. 7.

Revolving Welding Table. Ransome Concrete Machinery Co., Dunellen, N. J. Bulletin 151 describes compact unit for welding on revolving welding table. Pp. 2.

Boiler Meters. Bailey Meter Co., Cleveland, Ohio. Bulletin 46 contains an analysis of 7,000 combustion tests on all types and sizes of boilers, and illustrates and describes types of meters. Pp. 32.

Packings. Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill. Folder 5M138 describes packings for oil pumps, valve stems, etc. Pp. 4.

Water-Supply Systems. Roots-Connersville Blower Corp., Connersville, Ind. Bulletin 260-B13C describes water-supply systems for home or large camp purposes and data for estimating water requirements. Pp. 6.

Grinders and Buffers. U. S. Electrical Motors, Inc., 564 Fourth St., San Francisco, Calif. Folder 970 describes features of the company's Autostart grinders. Uniclosed Motor Folder 938 describes a dual fan-blast and dual exhaust ventilated motor. Pp. 3.

Transite Mine Drainage Pipe. Johns-Manville, 22 East 40th St., New York, N. Y. Form TR-20A contains complete information of the Transite asbestos-cement pipe to resist corrosion in the mine drainage field. Pp. 8.

Blowers. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1911 describes the manufacturer's single-stage burbo-blowers of the overhung type. Pp. 11. **Transformers.** Leaflet 2289 describes the 200-kva. and 150-kva. distribution transformers. Pp. 2. **Switchboards.** Bulletin 1190 describes various types of switchboard panels, pp. 7. **Small Electric Hoists,** Bulletin 1829A describes features of the company's small standard electric hoists.

Safety Devices. Willson Products, Inc., 260 Thorn St., Reading, Pa. Catalog illustrates and describes the manufacturer's complete line of eye, nose, throat, and lung protectors. Pp. 34.

INDUSTRIAL NOTES

George Riley, Montreal, Canada, recently left for England, where he will attend the annual meeting of Rip Bits, Ltd.

Promotion of Denn M. Burgess to the position of domestic sales manager from that of Eastern sales manager has been announced as a part of the sales management reorganization program of R. G. Le Tourneau, Inc., Peoria, Ill., and Stockton, Calif., manufacturers of heavy grading equipment.

Alloys Development Corporation, International Building, Rockefeller Center, New York, N. Y., has been formed by Dr. B. D. Saklatwalla and Frederick D. Foote, to develop and promote new materials for industrial and structural use. Dr. Saklatwalla was formerly active in the vanadium industry and is also recognized in the metallurgical field for his work in chromium-copper corrosion-resisting steels. Mr. Foote was formerly railroad industry executive in the commercial office of the United States Steel Corporation. The new organization succeeds United States Rustless Steel & Iron Corporation.

J. F. Lincoln, president of the Lincoln Electric Company, Cleveland, Ohio, announces establishment of a manufacturing subsidiary to be called Lincoln Electric Company (Australia), Pt., Ltd., at Sydney, Australia.

Nichols Engineering & Research Corporation announce the removal of its office to 70 Pine St., 31st floor, New York City.

J. E. Knapp, well-known used-machinery dealer with offices at 593 Market St., San Francisco, has sold his entire inventory and business to the Western Machinery Company, San Francisco.

G. V. Wood, formerly associated with Taylor-Wharton on the Pacific Coast, is returning from England to become Pacific Coast manager, according to an announcement by the Taylor-Wharton Iron & Steel Company, Easton, Pa.

Drilling With Detachable Bits—VI

IN THIS, the sixth and concluding installment of United States Bureau of Mines Information Circular No. 6951, written by McHenry Mosier, the data bearing on the practice of Western Mine No. 5 (presentation of which was begun in the April number) are completed. This mine affords the last of the several specific case studies. Then follow miscellaneous summaries, the article ending with three appendices.

Comparison of Hot-Milled Bits on Regular Drill Steel with Detachable Bits—On a special test in dense, siliceous sulphide with 1¼-in. drill steel and a 4-in. drifter equipped with automatic feed, the operating data shown below were developed. These results are favorable to the hot-milled conventional bit. They indicate that with the detachable bit there is a reduction in the penetration per bit of 16.5 per cent and a decrease in drilling speed of 3.4 per cent. In this test four different kinds of detachable bits were used. The figures in this comparison represent the detachable bit with the most favorable showing.

The detachable bits were used until either the clearance was lost or until the hardened steel shell was worn through. The number of bits that were reground after the first use was 70.8 per cent of the bits purchased. Fourteen and three-tenths per cent of the "first regrinds" were reground the second time. This totals 0.81 regrinds, or 1.81 uses, per bit purchased. The life of a detachable bit is 3.3 feet.

The cost of sharpening, reconditioning, and distributing, calculated on the per-foot-drilled basis and detailed in Table XVII, is 66.4 per cent greater for detachable than for hot-milled conventional bits. The estimated total cost per foot drilled would show a greater differential than this because of the decreased penetration and reduction in drilling speed with the detachable bits.

In the cost details, interest on the capital expense was computed at the annual rate of 4 per cent and depreciation at 10 per cent.

The construction cost of the drill-sharpening shop building was $5,000. For hot-milled conventional bits the purchase price of the shop equipment was $20,000 and the inventory value of the drill steel in circulation was $21,900.

For detachable bits, work would continue in the same $5,000 shop. The value of the shop equipment essential for detachable bits would be $7,500, and the inventory value of sufficient drill rods for all drilling throughout the mine would be $1,800.

Anaconda Copper Mining Company, Butte, Mont.

The Anaconda Copper Mining Company was one of the first of the large mining organizations to adopt the detachable bit. A complete description of the use of these bits at Butte may be found in an article by C. L. Berrien in Vol. 91 (1930) of the *Transactions* of the American Institute of Mining and Metallurgical Engineers.

The advantages of the detachable bit at this property in comparison with regular steel are stated in this article to be, (1) a reduction of 35.4 per cent in the cost per cubic foot excavated, (2) a saving of several hours per day at each mine in transporting drill steel through the shaft, (3) an adequate drill steel supply, and (4) greater ease and less hazard in transportation of drill steel.

Use of Detachable Bits at Small Mines, Compared to Large Mines

Figures that show the relative use of detachable bits by small and by large metal mines were furnished by a detachable-bit distributor who dominates this particular field in one Western State. These indicate that 92.3 per cent of the users of detachable bits in this State are small operators, and that 7.7 per cent of the users are large operators. The small mines accounted for 33 per cent of consumption and the large mines for 67 per cent.

Discussion of Life of Drill Rods

One of the vital factors in connection with the use of detachable bits is the life of the drill rods. Often the question is raised whether drill rods for detachable bits will deliver the same ultimate service in feet of hole drilled as will regular drill steel. The basis of this inquiry is the relative fatigue of steel that is used continuously and of steel that has short periods of use with long periods of rest.

"The generally accepted idea of the mechanism of fatigue failure is that of the progressive spread of a minute crack or of a plane of cleavage, from some nucleus.[1] The nucleus may be a

Table XVI—Hot-Milled Bits on Regular Steel Versus Detachable Bits. Western Mine No. 5

Item	Hot-Milled Bits on Regular Steel (*a*)	Detachable Bits
Inches drilled	3,066	2,085
Number of bits dulled	142	100
Inches drilled per minute	7.03	5.87
Inches drilled per bit dulled	21.59	20.85
Inches loss in gage per foot drilled	0.072	0.071
Average gage of bits, inches	1⅞	1⅞
Average air pressure, pounds per square inch	77.17	77.81

(*a*) These figures also used in comparison with straight forged bits above.

Table XVII Sharpening Shop and Distribution Costs

Item	Hot-Milled Conventional Bits on Regular Steel (*b*) Per Bit Dulled (*b*)	Hot-Milled Conventional Bits on Regular Steel (*b*) Per Foot Drilled (*c*)	Detachable Bits (*d*) Per Unit	Detachable Bits (*d*) Per Bit Dulled	Detachable Bits (*d*) Per Foot Drilled (*e*)
New bits	.....	.....	$0.23	$0.1271	$0.0730
Sharpening, total	$0.0497	$0.0276	0.0700	0.0313	0.0180
Labor	0.0420	.....	0.0625	.....	.....
Supplies	(*f*) 0.0077	.....	(*g*) 0.0075	.....	.....
Shanking	0.0006	0.0003	.....	.....	.....
Reconditioning rods, total	.....	.....	.....	0.0015	0.0009
Shanks	.....	.....	.....	0.0006	.....
Threads	.....	.....	.....	0.0009	.....
Steel replacement	0.0208	0.0116	.....	0.0036	0.0020
Distribution, total	0.0247	0.0137	.....	(*h*) 0.0066	0.0038
Underground nipping	0.0191	.....	.....	.....	.....
Hoisting and surface handling	0.0056	.....	.....	.....	.....
Interest on capital expense. Steel shop, equipment, and steel inventory	0.0060	0.0033	.....	0.0017	0.0010
Depreciation, steel shop and equipment	0.0072	0.0040	.....	0.0035	0.0020
Grand total	0.1090	0.0605	.....	0.1753	0.1007

(*a*) Over a recent twelve-month period. (*b*) 346,741 pieces of steel sharpened. (*c*) 1.80 ft. drilled per bit dulled. (*d*) Special test (see discussion and data presented in the foregoing.) (*e*) 1.74 ft. drilled per bit dulled. (*f*) Includes fuel (gas), compressed air, dies, dollies, and miscellaneous supplies. (*g*) Includes grinding wheels and electric power. (*h*) Estimated.

[1] Moore, H. F., Kommers, J. B., and Jasper, T. M.: "Fatigue or Progressive Failure of Metals Under Repeated Stress." American Society for Testing Metals, Vol. 22, Part 2, 1922.

minute region of high localized stress (the root of a screw thread, for example) or a minute flaw or region of weakness in the structure of the metal.

"Results of experiments show that the fatigue strength of iron and steel is greatly influenced by heat-treatment. Overheated steel is always weak, but can often be restored by reheating. Annealing in general decreases the endurance. Steel in the sorbitic condition seems to be especially strong against fatigue. It is certain, however, that the effect of heat-treatment must always depend greatly upon what the previous history of the material has been.

"From the few data that are available, it would seem that when metal has been subjected to repeated stresses it cannot be restored by annealing or by rest. The results are probably due to the fact that the metal had been so highly stressed or the number of repetitions so large that slip bands or actual microscopic fissures had been formed which were not healed by annealing."[2]

Metallurgists now agree that rest periods for drill rods have no benefit except in the psychological effect on the user, and that minute cracks once started cannot be healed. Because of this characteristic, rough handling of drill steel and drill rods, or any abuse in the shops, in transit, or in use that causes a nick or mark on the finished surface of the drill steel, is detrimental. Many mines have increased the life of drill steel and rods appreciably by careful handling, demonstrating the truth of the foregoing.

Life of Drill Rods at Miami Copper Company, Miami, Ariz.

Miami Copper Company has developed some interesting data on the life of drill rods for detachable bits. The following tabulations have been furnished by R. W. Hughes, mine superintendent. Table XVII shows the comparative life of rods fabricated from new bars, from broken bars that were reforged after the first and second failures, and from old drill steel of indeterminate service. This table indicates that new steel in its first service has the longest life; that, of the three classes under consideration, stoper rods render the greatest service and drifter rods the least; and that rods converted from old drill steel have only one-fifth of the life that is rendered by new steel in its first service.

Table XVIII segregates the failures by the length of the rods. It reveals that seconds have the highest breakage frequency and that drifter seconds exhibit the greatest rate of the three types.

[2] "Fatigue of Metals": Johnson's Materials of Construction, 6th ed. 1926, Chap. XXVIII, p. 825.

Table XVII—Life of Drill Rods

	New Steel						Old Steel From Used Drills			
	1st Service		2d Service		3d Service		1st Service		All Steel	
Section	Pieces	Days' Life	Pieces	Days' Life	Pieces	Days' Life	Pieces	Days' Life	Pieces	Days' Life
Drifter 1¼-in. round	81	35	21	16	2	28	19	10	123	28
Stoper ⅞-in. quarter octagon	21	93	10	32	1	19	0	0	32	71
Plugger ⅞-in. hexagon	32	58	7	30	0	0	2	8	41	51
All Steel	134	49	38	23	3	23	21	10	196	40

Table XVIII—Drill-Rod Failures Segregated by Length of Rods

Class	Drifter Failures	Length of Rod, Inches	Per Cent	Stoper Failures	Length of Rod Inches	Per Cent	Plugger Failures	Length of Rod Inches	Per Cent	Total Failures	Per Cent
Starter	24	30	16	7	30	15	9	24	17	40	16
(2d)	99	58	66	20	48	43	30	48	58	149	60
(3d)	26	86	17	15	66	32	12	72	23	53	21
(4th)	1	114	1	4	84	9	1	96	2	6	2
(5th)	..	..	..	1	102	1	..	..	..	1	1
Totals	150	..	100	47	..	100	52	..	100	249	100

Appendix I

Mine	Rock Drilled	Feet Drilled per Rod Broken: Conventional	Feet Drilled per Rod Broken: Detachable	Total Life Detachable Bit, Feet Drilled
Geneva	Granite	.....	.....	.....
Soudan	Greenstone, jasper, and iron ore	.....	.....	15.6
Greenwood	Jasper and hard iron ore	.....	120	8.6
Bates	Hard limonite	.....	.....	5.5
Montreal	Quartz slates	.....	.....	.....
Vulcan	Medium hard ore, slate, and cherty iron formation	.....	.....	.....
Calumet & Hecla	Copper ore	.....	.....	.....
Champion	Amygdaloid	.....	.....	8 to 16
Homestake	Siliceous ore	.....	.....	.....
Cliffs Shaft	Hard hematite ore	.....	.....	6.0
Mascot	Dolomite and limestone	.....	166	43.8
Bendelari	Limestone and flint	159	432	6.9
Barr	Flint and tiff	142	.....	4.0
Rialto	Limestone and flint	.....	2,133	9.6
A Mine in S. E. Missouri	Dolomitic limestone	11,340	.....	.....
Burra Burra	Metamorphosed sediments	320	.....	.....
London	Limestone, quartzite, porphyry, and vein matter	.....	.....	13.0
Climax	Silicified granite and schist	.....	320	28.8
Utah Apex	Limestone, quartzite, porphyry, and sulphide ore	.....	932	25.0
Idaho-Maryland	Schist, serpentine, diabase, diorite, quartz	.....	.....	17.2
Western Mine No. 1	Metamorphosed sediments diabase and porphyry	.....	341	44.6
United Verde Extension	Gossan, diorite, schist, greenstone, and porphyry	.....	200 (a)	10 (a)
Western Mine No. 2	Sulphide ore, diabase, and sediments	.....	328	35.3
Hillside	Schist with quartz lenses and ore	.....	.....	45 to 60
Western Mine No. 3	Schist, porphyry, diorite, sulphides, and ore	92	.....	8.6
Big Canon	Silicified schist	109	76	7.3
Western Mine No. 4	Monzonite porphyry, diorite, and rhyolite	.....	.....	48.3
Western Mine No. 5	Metamorphosed sediments, porphyry, and sulphide ore	.....	.....	3.3

Appendix II

Mine	Cost per Foot Drilled (a): Conventional Bits: Transportation of Steel	Nipping by Mines	Total	Total Detachable Bits
Geneva	....	.....	.....	.....
Soudan	.....	.....	.....	.....
Greenwood	.....	.....	$0.183	$0.105
Bates	.....	.....	.....	.....
Montreal	.....	.....	.....	.....
Vulcan	.....	.....	.....	.....
Calumet &Hecla	.....	.....	0.028	.....
Champion	.....	.....	.....	.....
Homestake	.....	.....	.....	.....
Cliffs Shaft	.....	.....	.....	.....
Mascot	$0.0026	.....	0.0928	0.0829
Bendelari	.....	.....	.....	.....
Barr	.....	.....	.....	.....
Rialto	.....	.....	.....	.....
A Mine in S. E. Missouri	.....	.....	.....	.....
Burra Burra	.....	.....	.....	.....
London	.....	.....	.....	(b) 0.1975
Climax	0.0198	0.0198	(c) 0.043	(c) 0.026
Utah Apex	0.0578	.....	(c) 0.1093	(c) 0.0170
Idaho-Maryland	0.0170	.....	0.0607	0.0399
Western Mine No. 1	0.0209	.....	(d) 0.0466	(a) 0.0060
United Verde Extension	.....	.....	.....	.....
Western Mine No. 2	0.0223	0.0223	(f) 0.2368	(g) 0.1306
Hillside	.....	.....	.....	.....
Western Mine No. 3	.....	.....	.....	.....
Big Canon	(h) 0.0300	.....	0.1008	(i) 0.1118
Western Mine No. 4	0.0190	.....	(c) 0.0510	(c) 0.0277
Western Mine No. 5	0.0137	.....	(c) 0.0605	(c) 0.1007

(a) The above costs do not include drilling labor and compressed air. (b) Includes operating rock drills. (c) Cost of steel and bits, shop expense, and transportation. (d) Shop and transportation only. (e) Shop costs only (exclusive of cost of new bits). (f) In stopes, raises, and shafts. (g) In drifts. (h) Approximate. (i) Detachable bits used in special work where transportation cost is higher than average shown.